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PROCEEDINGS

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THE SPERM-RECEPTACLE IN THE CRAYFISHES, CAMBARUS CUBENSIS AND C. PARADOXUS.

BY E. A. ANDREWS.

IN some of the crustacea all of the sperm that is to fertilize the eggs is left by the male on the outside of the female and in some others it is deposited in external receptacles. Both these exceptional modes of transferring the sperm are met with in the crayfishes and lobsters.

As far as known in all the crayfishes of the world, except those of North America east of the Rocky Mountains, the male deposits the sperm on the outside of the shell of the female, and not in any receptacle. But in the above crayfishes of the central and eastern parts of North America the sperm is deposited in special receptacles in the shells of the females, and the same is true for the American lobster.

Before describing the sperm-receptacle in a Cuban and a Mexican crayfish in which it was necessary to find it in order to prove its general occurrence in all members of the genus *Cambarus*, we will make a comparison of the receptacles in the crayfish and lobster.

In both animals there is but one receptacle on each female and this lies on the under side of the body, between the fourth and the fifth pairs of legs.

The under side of the shell of the thorax of these animals may be thought of as made of more or less fused plates, one on each side and one on the middle of each somite. In the somites of the first, second and third legs the imagined plates

are all fused into one mass, forming a groove, with the middle plates as the bottom and the side plates as the elevated edges to which the legs join. But between the fourth legs the middle plate is recognizable as a distinct part of the sternal skeleton and we will call it the annular plate as in the female crayfish of the genus *Cambarus* it is specialized as the so-called *annulus ventralis*, that contains the sperm-receptacle. In the next somite, which bears the fifth legs, the middle plate is separate and often spine-like while the side plates stand up on edge as diagonal wings.

While the receptacle in *Cambarus* is contained within a single middle plate, in the lobster it is formed by three plates, one middle plate and two side plates, and thus though it has the same position and the same physiological value it has not the same morphological value. This will be more evident after a description of the receptacle in the lobster, where it was first recognized by Bumpus in 1897 (J. M., Vol. V). This organ is made by two side wings or plates of the fourth leg-bearing somite together with a wedge-like middle piece. These three plates surround a middle space which is several mm. long, somewhat less in width and more in depth. Bumpus states that it may be filled, in part, by a mass of sperm and largely by a wax-like substance.

In the lobster the legs are inserted so close to the middle line that the side plates come into contact at the middle line between the fourth legs, but passing diagonally backwards flare apart so that the middle or wedge-plate pushes in between them. The receptacle is just above the wedge-plate which underlies it and shuts it off from the exterior, as it runs forward like a slanting shelf from its broad posterior base to its small, free tip. The receptacular space would thus be entirely shut off and inaccessible were it not for the fact that the two side plates in front of the tip of the wedge may easily be forced apart by inserting between them the hard, spatula-like tips of the male stylets, or first abdominal appendages, which are very well fitted for this purpose. Once inserted these organs are not readily removed since the special ridge each bears, catches on the face of the lateral plate. The lateral plates are normally

kept close together by the elasticity of the soft cushions formed by the thin inner face of each plate. While the wedge-plate is especially well calcified, the walls of the side plates, or wings, remain membranous over most of their inner faces, so that much of the lining of the receptacle, as well as the entrance to it, is not brittle shell, but thin chitinous material.

Looked at from the inside of the body the protruding plates of the under surface of the body are not solid thickenings of the shell, but hollow protuberances, and from this standpoint the receptacle may be described as an external space embraced on the sides by two pouches of the shell, the right and the left wing, and by a middle floor, a long, pointed pouch, the wedge.

It should be emphasized that the receptacle is merely an enclosed region outside the body of the lobster, and that, as far as known, it has no communication with any internal structure.

To determine the homology of this organ it is important to know if all its parts belong to one somite or not. At first sight the wedge-plate seems to belong to the somite bearing the fifth pair of legs, as it sticks forward from the sternal ridge joining these legs, while the side wings belong to the somite bearing the fourth legs. But there are some reasons for holding that the wedge belongs to the somite bearing the fourth legs, though Herrick (The American Lobster, 1895), from a study of several stages in the formation of the receptacle in young lobsters, concluded that the wedge-plate belonged to the somite of the fifth legs. However, an examination of his Fig. 5, Plate 33, suggests that the cross line between the fourth and the fifth legs is homologous with the similar line, which we have shown to be the boundary of the annulus in young crayfishes (Biol. Bull., 1906), and as the annulus seems to belong to the somite of the fourth legs, it may be that Herrick was in error in assigning the wedge to the somite of the fifth legs. Again, in the series of middle and side plates, the middle plate stands a little posterior to the line joining the side plates of its somite, as far as one can judge from the adult condition, so that a recession of the middle plate from its side plates is what is to be expected, while the existence of a middle plate in advance of the side plates would be exceptional. Thus there is a middle plate posterior to the

wings of the fifth legs, and there should be a middle plate posterior to the wings of the fourth legs, and as such a plate we may assume the wedge that projects forward from the line joining the fifth wings.

In the male lobster the wedge of the female is represented by a flat plate that is somewhat grooved along the middle. This plate of the male may very readily be regarded as a middle plate of the fourth leg region shoved back onto the somite of the fifth legs.

Another mode of judging of the homology of the wedge and its morphological position is a study of the internal skeleton, or endophragmal system. In the crayfish there are transverse ridges on the inside of the shell, between the side wings and the middle plates, and from these arise the long internal bars, or endosternites, that run up into the interior of the body, one on the right and one on the left. In the male it is easily seen that the endosternites come in between the wing plates and the middle plate of the somite bearing the fourth legs and also between the wings and middle plate of the somite of the fifth legs. In the female the same is true except that the wide annulus takes the place of the narrow annular plate of the male.

The endosternites cannot be taken as exact bounds of the somites, else the middle plate of the last thoracic somite would be reckoned as on the abdomen, which the general conformation renders unlikely.

In the lobster the extreme narrowness of the sterna brings the endosternites close together at the middle line: but in the male one can see that there is a pair of endosternites between the middle plate and the wings in front of it on the last somite and also between the hollowed out wings of the somite bearing the fourth legs and a middle plate which may be regarded as the annular plate. In the female the only difference is that the peculiar development of the wings and the wedge raises the endosternites of the boundary between these plates up onto the top of the seminal receptacle, where they were noticed by Herrick as parts of the endophragmal system.

It should also be noted that in the male lobster the receptacle is represented by a triangular pit, some two mm. wide, deep

and long, between the wings of the fourth legs and a rather flat plate that may be regarded as belonging to that same somite.

Deciding that the wedge-plate really belongs to the somite of the fourth legs we find no difficulty in homologizing it with the annulus of the crayfish. We will call the wedge-plate an annular plate. The only reason that this is not self-evident is that the annular plate of the lobster is secondarily pushed far back and fused to the sternal skeleton of the fifth leg somite. Even in the crayfishes there is a marked recession of the annular plate and in the lobster which has not the freedom of motion between the fifth and fourth somites that is found in the crayfish, the backward migration and fusion could take place to a greater extent.

However, to establish the homology of the wedge with the annular plate it is not necessary to show that they are on the fourth leg somite, but only that they are on the same somite: so that if the endosternites be taken as the exact bounds of the somites both the annulus and the wedge would belong to the somite of the fifth legs, but still be homologous.

While the receptacle of the lobster is a space between the side plates and an annular plate the receptacle of crayfishes is entirely within the annular plate itself: hence the two receptacles are not homologous, though one element of each is the same, the annular plate.

The general facts regarding the receptacle of the crayfish are as follows: In the crayfishes of Europe, which are all of the genus *Astacus*, it is said that the sperm is scattered over the posterior part of the sternum of the thorax of the female, enclosed in tubes of paste-like material, the spermatophores. Yet there is, in both sexes, an annular plate, slightly marked off from the great fused sternal mass that ends between the fourth legs. The same is presumed to be true of all the crayfishes of Asia and of North America, west of the Rocky Mountains as they are all of the same genus, *Astacus*. On the other hand in the three score and more crayfishes of the genus *Cambarus*, found east of these mountains the annular plate is variously sculptured and provided with a suture. Hagen, who discovered this annular plate (Monograph N. A. Astacidæ, 1870), supposed it had some gland-

ular function, but he recognized that it was a good aid in describing species of *Cambarus* and called it the *annulus ventralis*. Since then it has been constantly made use of as a specific character. In 1895 we showed that the male of *Cambarus affinis* deposits the sperm within a cavity in the annulus and subsequently we described the seminal receptacle in several species of *Cambarus* as a narrow pocket in the wall of the annular plate, which arose in the young female as a shallow epidermal pit that later deepened as a zigzag pocket.

In all crayfishes except *Cambarus* no receptacle is known and no specialization of the annular plate is known outside of the females of *Cambarus* and of the American lobster. Yet some sort of receptacle may yet be found in other crayfishes. Thus the crayfishes of eastern Asia have the annular plate hollowed out posteriorly, the male stylets armed wih complex points and the legs provided with hooks, all of which leads one to predict that a renewed search will discover some kind of sperm-receptacle in these crayfishes. In that event the resemblances that led Faxon to call these crayfishes *Cambaroides*, as being like *Cambarus*, would be strengthened in a way that might add to the puzzling nature of the problem here presented of close resemblances between animals in the eastern and westenr areas of the continents, North America and Eurasia along with generic differences between the east and west of each continent.

Having shown that in *Cambarus affinis* the sperm put by the male into the annulus will remain alive all winter and that the eggs laid in the spring will develop if this sperm is present till then, though they did not develop when the annulus was removed, it was concluded that the sperm-pocket of the annulus was an essential link in the chain of reproductive organs, without which Cambari would come to an end.

To make way for a consideration of the possible mode of origination of this peculiar organ, which seems to have no exact homologue in other crustacea nor in other animals, as it is an unpaired, ventral, and not segmentally repeated organ, used only for the storage of sperm, it seemed important to make more sure that the annulus in all kinds of Cambari contained a sperm-receptacle of the same nature.

Ortmann having shown that the genus *Cambarus* (Proc. Wash. Acad. Sci., 1906) could be divided into six subgenera; the existence of the sperm-pocket in random members of all subgenera would approximately establish its presence in all the members of the genus. The annulus was found to contain a sperm-pocket of the same fundamental structure (but with specific differences) in species of the subgenera, *Faxonius*, *Bartonius* and *Cambarus* (Proc. Boston Soc. Nat. Hist., 1906) and later the same was found true for a species of the subgenus *Cambarellus* (Biol. Bull., 1908).

In the present paper the annulus is described in crayfish of the two remaining subgenera, *Procambarus* and *Paracambarus*, and the same sperm-pocket found in all.

Owing to the kindness of Dr. Ortmann, I have been able to study the annulus in six specimens of *Cambarus* (*Procambarus*) *cubensis* Erichs., and in one of his type specimens of *Cambarus* (*Paracambarus*) *paradoxus* Ortm. The former came to him from the Rio Almendares, Calabazar, Prov. Habana, Cuba, and the latter from the state of Puebla, Mexico, through the Paris Museum. These specimens of *Procambarus* had so many lost and regenerating limbs that this species would seem to be an especially favorable one for the study of regeneration.

In this Cuban crayfish the annulus is known from a description of Faxon (Revision Astacidæ, 1885) to be "composed of a larger anterior, bilobed tubercle and a smaller posterior tubercle" and Ortmann found that it showed an S-shaped fissure on the posterior tubercle. This fact and the figure given by Ortmann left little doubt that, when looked for, a sperm-pocket would be found within this annulus. However there was doubt as to what should be regarded as the real annulus since Faxon gave the name to all three tubercles, while Ortmann stated that it seemed to him only the posterior tubercle ought to be regarded as the annulus.

The following illustrations, in the light of the above considerations as to the morphology of the annular plate, will show that although the receptacle is all within the posterior tubercle, yet that alone is not the annulus, but all three tubercles together form the annulus.

The width of the whole set of tubercles is about 2 mm. in a female 48 mm. long, say 3 per cent. to 4 per cent. of the length, which is the usual proportion of annulus to body length. But the posterior tubercle, or "subannulus," as it might be called,

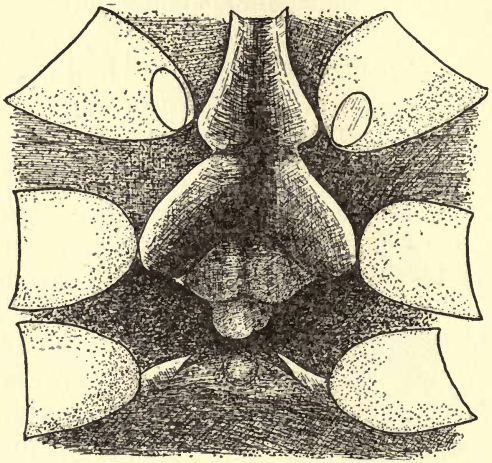

FIG. 1. Ventral view annulus and neighboring region of female 50 mm. long, $2a_0$.

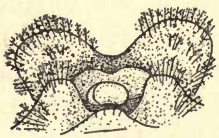

FIG. 2. Posterior view annulus and neighboring organs of a female 35 mm. long, right handed, $2a_0$.

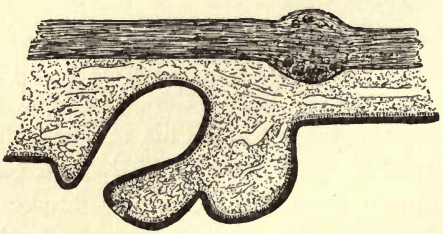

FIG. 3. Median lengthwise section of annulus and neighboring organs. Same specimen as in Fig. 2, 2.90 mm., *A*.

is only .75 mm. wide and .5 mm. long and thus not the right size for an annulus.

Fig. 1 shows, right and left, the basal segments of the third, fourth and fifth legs with the elliptical openings of the oviducts

on the third legs. Between the fourth legs are the flaring side or wing plates, and between the fifth legs are two similar plates which being set on edge show better from a posterior view, Fig. 2. Between the fourth and the fifth legs is the mass of three tubercles, shown enlarged in Fig. 4. Between the fifth legs there is a small tubercle serially homologous with the above set of three that form the annular plate.

The structures indicated in Fig. 1 are fringed with setæ but these are represented only in Fig. 2, which is a view from behind. These setæ add to the difficulty mentioned by Faxon and by Ortmann, of finding the annulus.

Fig. 2 shows in the foreground the low middle plate, or spine, of the sternum of the fifth legs and right and left of tha

FIG. 4. Ventral view of annulus of female 38 mm. long, 2.90 mm., *A*.

the side wings of the same somite. In the background are the larger wings of the fourth leg somite and at the center the tubercles. The posterior tubercle stands out free, attached only along its contact with the paired tubercles, so that it can be moved up and down, while the anterior tubercles are pretty firmly soldered to the fused sternal mass anterior to them. The sides of the anterior tubercles reach under the flaring wing plates, as seen in Fig. 4, so that the entire set of tubercles has the proper form and connections for an annular plate. The peculiarity is that the posterior part of the annulus is set off as a rounded tubercle, which is not known to be the case in any other crayfish. As the posterior lobe is found to contain the

sperm-pocket it is not a new formation, fundamentally, but only a specialization of the posterior part of an annular plate. The two other tubercles seem to correspond to the paired elevations met with on the anterior part of the annuli of some of the higher Cambari.

In a median, lengthwise section, Fig. 3, the posterior lobe of the annulus is seen to stand out from the rest of the annulus like a fungus from a tree, forming a rounded shelf. Dorsal to this shelf there is a large space and the black line that represents the shell coming from the head, toward the right of the observer, rises up over the protuberant anterior part of the annulus, between the anterior tubercles, and sweeps around a deep cavity, to

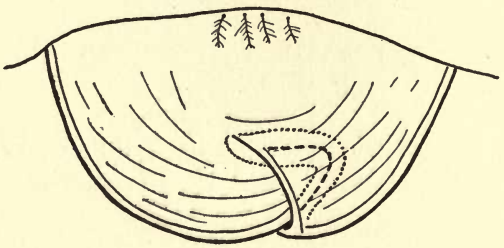

FIG. 5. Ventral view of posterior lobe of annulus of female 45 mm. long, left handed, 2*A*.

finally emerge over the summit of the small spine of the somite of the fifth legs. This figure also shows the epidermis that lines the shell and the vascular, sponge-work tissue that fills out the annulus and all the adjacent region up to the nerve cord, on which is represented the ganglion of the somite that bears the fourth pair of legs.

The peculiarity of this annulus is that it contains the essential, sperm-receptacle in the projecting posterior lobe.

This receptacle agrees so closely in structure with the pockets that contain sperm in the higher species of *Cambarus* that there is no doubt that it is used as a sperm-receptacle, though no sperm was found in it in the five females examined. The appearance of the pocket as seen in the posterior lobe of the annulus made translucent, is represented in Fig. 5. The pocket is an oblique slit that leads off to the observer's right as far as

the broken line, which represents its bottom. It is a very narrow and not very deep pocket. The dotted lines indicate the walls of the pocket and these are the continuations of the thick shell, running in to line the pocket.

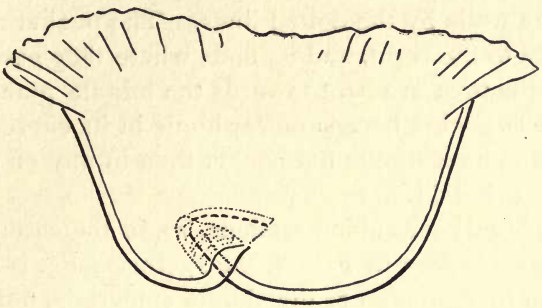

FIG. 6. Dorsal view of same specimen, 2*A*.

As shown in Fig. 6, this pocket comes to an end on the dorsal face of the posterior lobe of the annulus, after curving around the posterior face. Coming up from the left of the observer the mouth of the pocket runs a very short distance and the part of the pocket directly at this end is very short, but

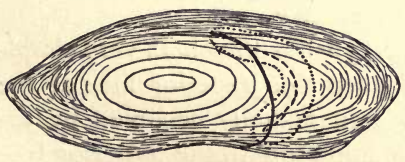

FIG. 7. Posterior face of posterior lobe of annulus of the same specimen, 2*A*.

FIG. 8. Section of part of posterior lobe of annulus of left-handed female 30 mm. long, 2*D*.

through the thickness of the annulus the other, or ventral end of the pocket, is seen above and to the right of the figure. This becomes easy of comprehension when the sperm-pocket is viewed directly from the rear, as in Fig. 7. From this view the

posterior lobe of the annulus is seen to have a convex ventral surface, a somewhat concave dorsal surface and rather sharp edges, right and left. The mouth of the sperm-pocket is the somewhat crescentric narrow cleft, represented by the black line. The bottom of the pocket is represented by the broken line and the walls by the dotted lines. The pocket thus passes in obliquely to the right, and its ends where they pass over onto the top and bottom are bent towards the middle plane.

The sperm-pocket here is more simple in its curves and more easily seen to be a simple flat pocket than in any of the higher Cambari yet studied.

In more highly magnified sections, as in the coronal section, of which part is seen in Fig. 8, the sperm-pocket is seen to be made by an invagination of the simple epidermis, but the cavity of this pouch is largely filled in by the thick shell which the epidermis has made and which is continued in from the thick shell covering the rest of the annulus. The shell keeps its usual character, having a thick, laminated inner part near the epidermis, a much thinner outer part that is represented as clear in the figure, and an outermost cuticle that is indicated by the bounding line of the figure. The cavity lined by this shell is very narrow and but slightly dilated at the bottom, yet it is ample to contain innumerable sperms. It is probable that in life, before the action of reagents, the two sides of the pocket are so firmly in contact that the cuticular layer on each side may allow no water to pass into the receptacle.

The sperm-receptacle of this crayfish is thus both very simple and restricted to a small part of even the posterior lobe of the annulus. In Fig. 3 the small area actually occupied by the pocket is indicated by the little impitting in the posterior face of the posterior lobe of the annulus, though in an exactly median section this invagination would not show, as it is a little to one side of the middle on the posterior edge, Fig. 7.

The great bulk of the interior of the annulus is filled with areolated, spongy tissue represented in Figs. 3 and 8, and this is full of blood and scattered corpuscles, as indicated in Fig. 8. No glandular nor muscular tissues were found and no nerves, though special search should show nerves for the few setæ found on the ventral surface of the annulus, Fig. 5.

One unexpected feature of the annulus of the genus *Cambarus* is the fact that it enables one to recognize a dimorphism amongst the females of some, if not all, the species. The females are either right handed or left handed in the sense that the sperm-pockets are so placed and bent that some females have sperm-pockets which are the mirror images of the pockets of the other females of the same species. Indications are that about one half are of one kind and one half of the other.

Though the sperm-receptacle is, in general terms, a median structure it never lies entirely along the exact middle plane nor is it exactly balanced, right and left, as are so many organs in the anthropods.

In this Cuban *Cambarus* we find another illustration of this dimorphism expressed in the annulus of the females. Of the six specimens studied, four were left and two right handed. The lengths of the right-handed ones were 35 and 38 mm.; of the left handed 30, 45, 45, 48. Thus the dimorphism is probably not a matter of age nor something that alternates in successive periods of the same female as does the dimorphism, so-called, of the males of the other Cambari. The differences between the two forms of females are as follows: In the left-handed females the sperm-pocket lies a little to the animal's left of the middle of the body, Figs. 1, 5, 6, 7. In the right-handed female it lies to the right, Figs. 2, 4. Moreover in the two cases the pockets slope in opposite directions, so that the right-handed pocket is the mirror image of the left-handed one shown in Fig. 7; that is, it looks like that one seen through the paper from the other side. The crescent-like mouths of the receptacles in the left-handed females open to the right and those of the other to the left, so that they are to one another as new moon and old moon.

The entire posterior lobe of the annulus is also right or left handed, that is to say, in the left-handed females the most prominent part of the posterior face of the annulus is slightly to the right of the middle and the right side is the bigger, Figs. 1, 5, 6, 7. In the right-handed females the more protuberant part is on the animal's left, as in Fig. 4.

Thus taking the species as a unit there exists a symmetrical

pair of sperm-pockets: each female possessing but one of a symmetrical pair, while its mirror image is to be found upon some other female.

The sperm-pocket of this species of crayfish, representing the subgenus *Procambarus*, is thus fundamentally identical with the sperm-pockets in all the other Cambari, thus far studied.

Turning now to the only specimen of the subgenus *Paracambarus* as yet examined with reference to the sperm-pocket

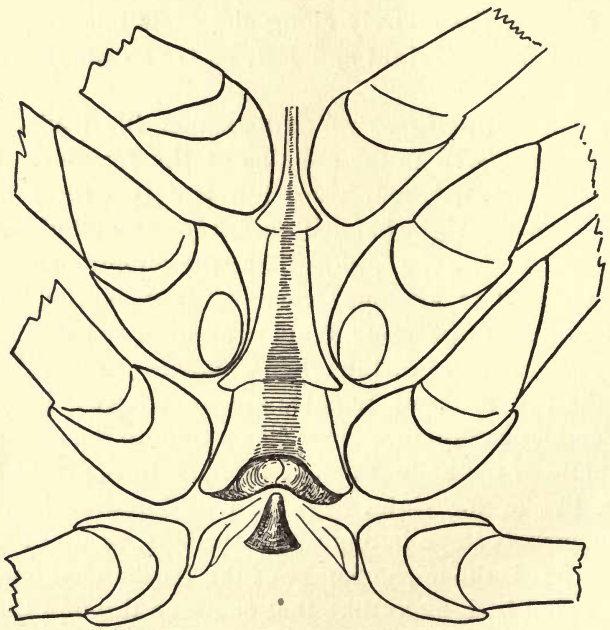

FIG. 9. Ventral view of annulus and neighboring organs of female 45 mm. long, $2a_0$.

within the annulus we find the general appearances indicated in Fig. 9. The annulus itself is not so remarkable but the spine between the fifth legs attains a height not elsewhere known. The figure shows the bases of the second to fifth legs inclusive and the grooved sternal mass that ends between the fourth legs with flaring wing plates and a concave middle plate. In the concavity so formed lies the annulus, which differs from the usual form chiefly in rising up rather more in the middle

and in being decidedly concave on the posterior face. When isolated it has the form indicated in Fig. 11, with the mouth of the sperm-pocket lengthwise along its high middle part.

Posterior to this annulus the middle plate between the fifth legs is developed as a very high spine, which is shown in its true proportions and relations to other adjacent organs in Fig. 10. In this side view, with one half of the body cut away, the tall, conical, or somewhat flattened spine juts forward to overhang the annulus, which in turn stands up above the general level of the mid-region of the sternum. The spine bears at its apex several long and sparsely plumose setæ and a scant fringe of much shorter setæ is found along the edges of the wing plates of the fourth and fifth legs. In the background of the figure are the bases of the fourth and fifth legs. The side plates are here seen in their true elevation, while in Fig. 9 they are seen on edge.

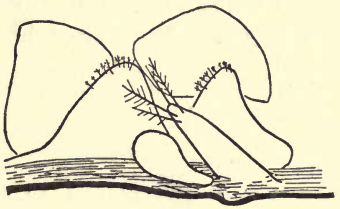

FIG. 10. Side view of annulus and post-annular spine, left half of body removed, $2a_0$.

In crayfishes the last thoracic somite is movable and the hard middle plate or spine of this somite may be readily shoved against the hind edge of the annulus. In *Cambarus affinis* there is reason to believe that the female so shoves the middle plate against the annulus as to liberate the sperms when they are needed to fertilize the eggs, as these glide out of the openings on the third legs and thence back over the annulus. In *Procambarus cubensis* the low simple spine, Figs. 1, 2, 3, may thus act against the low posterior face of this annulus and, on the other hand, in *Paracambarus paradoxus* the very tall spine may be useful against the unusually high annulus, which is concave on its posterior face, as if to receive the spine. While the very tall spine may thus find its use in connection with a very high annulus, as yet no use has actually been demonstrated, and the great development of the spine in this *Paracambarus* may not have any value. The spine is a specialization of the middle plate of the last thoracic somite and as such is to be regarded as homologous with the annulus, so that the

unusual height of the spine may be correlated with the height of the annulus as variations of serially homologous structures, whether there is any use for the spine or not. Returning to the annulus we find in it the usual sperm-receptacle, of much the same character as in the higher species and more complex than in *Cambarus cubensis*. The mouth of the pocket is a sinuous groove between elevated lips running across the convex ventral face and extending a little distance onto the anterior and posterior faces. Beginning on the anterior face, Fig. 11, the narrow mouth passes back from the middle line toward the left of the

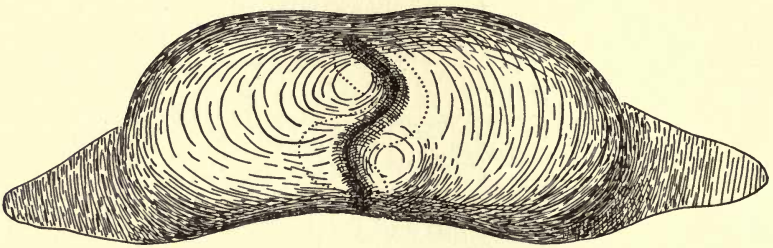

FIG. 11. Ventral face of annulus, 2*A*.

animal under the edge of a high, rounded tubercle. When the annulus is seen from the front this tubercle is the highest point of the annulus and from it the annulus slopes right and left more steeply than is indicated in Fig. 11.

On the convex ventral face the mouth makes a U-shaped curve to the animal's left and then a like one to the animal's right, to finally pass onto the posterior face. Embraced in the second curve is a second tubercle, less elevated than the anterior one and on the opposite side of the mouth. On the posterior face the mouth is seen as a short curved line coming down over the edge about on the middle line and with quite an elevation on the observer's right, close to the mouth.

As is faintly outlined in Fig. 11 the pocket into which this doubly bent mouth opens lies below it and not off to one side as much as in *C. cubensis*, yet a more careful sketch, Fig. 12, shows that the plane leading from the mouth to the bottom of the pocket does slant somewhat and is not at right angles to the surface of the annulus. Fig. 12 represents the sperm-pocket as

seen in a specimen made transparent; the broken line stands for the bottom of the pocket and the parallel rulings indicate the cavity of the pocket, which is about the same thing as a plane passed from the mouth to the bottom, since the width of the pocket is so little. It will be seen that the cavity of the pocket inclines first to the right, then to the left and again somewhat to the right, nearest to the observer. The bottom is thus more sinuous than the mouth; the broken line in the figure more bent than the continuous line that represents the mouth. Such inclination of the sperm-pocket is the rule and the S-shaped curve is common in the higher species. In another point this sperm-pocket suggests the complex conditions in the annuli of *C. virilis* and *C. affinis*, and that is, the conformation of the posterior part of the pocket. The bottom of the pocket is not coextensive with the mouth, so that the mouth runs along the surface beyond the limits of the bottom, both at the anterior and the posterior ends. At the posterior end the connection of the mouth with the bottom is by an inclined passage, sloping from the surface forward. This passage is slightly dilated right and left, as indicated in Fig. 12. This little chamber so formed is quite near the surface and farther from the bottom of the pocket. It seems to be the same thing as the "recess" in which the sperm remains longer than elsewhere in the annulus of *C. affinis*. But this chamber is easily understood in this species, while in *C. affinis* it is obscure at first view.

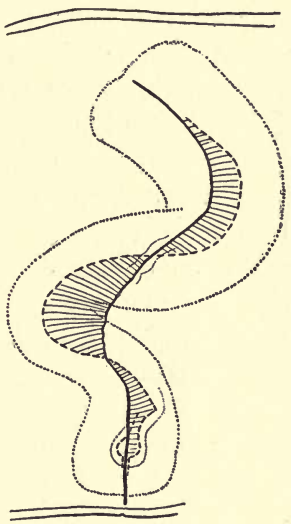

FIG. 12. Ventral view of sperm-pocket, as translucent object, 4*A*.

The thick shell walls of the pocket are indicated in the figure by the dotted lines; the shell that lines the pocket was removed, in preparation, from the epidermis and then it was seen that the epidermis that had formed this pocket was an S-shaped, deep groove, out of which the S-shaped shell represented by the dotted

lines, had been pulled. Thus, here, as elsewhere the shell-pocket shown in Fig. 12 is cast in an epidermal mould of like form, a mould that exists as an epidermal groove. The epidermal groove secreted so thick a shell as to fill up the groove, all but a narrow slit, and it is this narrow cavity that doubtless is filled with sperm by the male, though in this single specimen no evidence of sperm was found.

A cross-section of this sperm-pocket would be essentially like Fig. 8.

From this one female it is impossible to say whether this species is dimorphic or not, but one may confidently predict that an examination of many specimens would show that there are both right- and left-handed forms. Some would have the sperm-pocket the mirror image of that shown in Fig. 12, so that these females would have the suture reversed and the pocket inclining the opposite way at each turn, as compares with Fig. 12.

We have thus demonstrated that the same sort of sperm-pocket is found in these two crayfishes, *Cambarus cubensis* and *Cambarus paradoxus*, as in all other species of *Cambarus* yet examined and have now found the same essential structure in the annuli of representatives of all the six subgenera of *Cambarus*, so that the sperm-pocket may be regarded as the fundamental feature of the annulus of all the Cambari.

SUMMARY.

The sperm-receptacles found on the ventral surface of the lobster and of the crayfish of the genus *Cambarus* are not homologous with one another, though they have the same use and location. In the lobster the receptacle is an external space covered over by the annular plate of the seventh thoracic somite; in *Cambarus* the receptacle is a narrow pocket invaginated into that same annular plate.

It is shown that in each of the six subgenera of *Cambarus* the annular plate contains the same sort of pocket and hence it is most probable that sperm is stored up in such pockets in all species of Cambari.

The middle plate of the eighth thoracic somite is homologous with the annulus and is variously modified as a hard plate or spine that may be pushed against the annulus. Probably the female brings about the discharge of the sperm from the annulus by use of this plate or spine, when the eggs are being laid.

BALTIMORE, March 21, 1908.

EXPLANATION OF FIGURES.

Drawn with camera and the Zeiss lenses indicated, reduced ½ diameters.

Figures 1–8, *Cambarus* (*Procambarus*) *cubensis*.

Figures 9–12, *Cambarus* (*Paracambarus*) *paradoxus*.

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

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NOTICES OF DECEASED MEMBERS.

William Harris Ashmead.

1855–1908.

WILLIAM HARRIS ASHMEAD, Assistant Curator Division of Insects, United States National Museum, one of the foremost American workers in systematic entomology, died in Washington October 17, 1908, after a lingering illness. Although his death had been expected for some months, owing to the character of the malady that laid him low, it was none the less a great shock to his wide circle of friends among the scientific community of Washington and to the members of the Washington Academy of Sciences, of which he was a charter member, and of which he had been on several occasions Vice-President from the Entomological Society of Washington.

Doctor Ashmead was born in Philadelphia September 19, 1855. He was the son of Captain Albert Ashmead and Elizabeth (Graham) Ashmead, and came of fine old colonial ancestry on both sides. He was educated in the private and public schools of Philadelphia, and early in life entered the publishing house of J. B. Lippincott Company, of that city. Some years later he went to Jacksonville, Fla., and with his brother established a printing house for the publication of agricultural books and other matter. He founded an agricultural weekly, and a daily entitled *The Florida Dispatch*. He edited the scientific department of the weekly, devoting himself chiefly to

the investigation of injurious insects. Through his interest in this field, which became very great, he gradually built up a large collection of insects; and, experiencing great difficulty in securing determinations, began the study of systematic entomology. From the very first he was a tremendous worker and produced results with astonishing rapidity. His contributions to the scientific journals began in 1879, and from that date until the time of his final collapse he produced a long series of contributions to science, comprising more than 250 titles and including many papers of great systematic value.

In 1887 he received an appointment as Special Field Entomologist to the Division of Entomology of the United States Department of Agriculture, for the investigation of certain Florida problems. In 1888 he was appointed Entomologist to the State Agricultural College and Experiment Station at Lake City, Fla., and while holding that position, published one of the very first bulletins produced by an entomologist of an agricultural experiment station under the Hatch Act. It was entitled "Notes on Various Injurious Insects." In 1889 he was made an assistant entomologist and investigator of the Division of Entomology of the United States Department of Agriculture. During the winter of 1889–90, on leave of absence, he went abroad and studied for several months in Berlin. On his return he continued his work under the Division of Entomology, and in 1895 was appointed Assistant Curator of the Division of Insects, United States National Museum, which position he held until a few months before his death. He donated his large private collection to the Museum about 1898.

As a worker Doctor Ashmead was possessed of an enthusiasm and of an industry that has rarely been equaled. For many years he allowed himself but five hours, or a little more, sleep, devoting the remainder of his time, with the exception of that needed for eating, to an incessant study of the forms in which he was for the time interested. The amount of work thus accomplished was enormous. Either of his two main works, namely, his Monograph of the North American Proctotrypidæ, published as Bulletin 45 of the United States National Museum, a work covering some 500 pages, or his Classification of the

Chalcid Flies or the Superfamily Chalcidoidea, published by the Carnegie Museum, Serial No. 21, a quarto volume of 335 pages, would have been enough to have monopolized the working part of the lifetime of any one ordinary man. But aside from these he left nearly ready for publication a great monograph of the Braconidæ, and he had published very many smaller classificatory papers of high standing.

Doctor Ashmead was given the degree of Master of Science by the Florida State Agricultural College, and in 1904 was made a Doctor of Philosophy by the Western University of Pennsylvania, the Monograph of the Chalcidoidea just mentioned having been submitted as his thesis. He was prominent in scientific circles. He was a fellow of the American Association for the Advancement of Science, and a corresponding member of the American Entomological Society of Philadelphia. He had been Vice-President of the Biological Society of Washington, President of the Cambridge Entomological Society (1894), President of the Entomological Society of Washington (1894–5), Vice-President of the Washington Academy of Sciences (1888, 1893, 1894), honorary member of the Entomological Society of Ontario, and Vice-President of the Association of Economic Entomologists (1892). He married in Philadelphia in 1878, Harriet, the daughter of Thomas O. Holmes. He leaves a widow and one married daughter. He was a member of the Cosmos Club, of Washington, and of its very important committee on admissions.

When he came to Washington he was a man of large property, which however, was greatly reduced by the disastrous Jacksonville fire. This, however, did not appear to prey upon his mind and he remained until the end the same cheerful, tireless worker in the field of pure science. Like so many indefatigable workers in science, Dr. Ashmead was most helpful to his fellow workers. His knowledge and his time were always at the disposal of other workers, and he was noted for his helpful attitude towards younger investigators. He had the kindest of hearts, and will always be remembered by those who knew him.

L. O. Howard.

George W. Atherton.

1837–1906.

GEORE W. ATHERTON, president of The Pennsylvania State College, died at State College, Pa., on July 24, 1906.

He was born at Boxford, Mass., on June 20, 1837, coming of good New England stock. Left fatherless at the age of 12, he supported himself and aided his mother and sisters by work in a cotton mill and later, on the farm and by teaching. He worked his way through Philips Academy, Exeter, N. H., and in 1860 entered the sophomore class at Yale. At the outbreak of the Civil War he responded to the call to arms, and on recommendation of President Woolsey was commissioned First Lieutenant in the Tenth Connecticut Volunteers. He took part in Burnside's North Carolina expedition, where he served with conspicuous bravery and efficiency, and was promoted to a captaincy.

Leaving the army in 1863 on account of failing health, he was graduated from Yale with his class, and on Christmas of the same year was married to Frances D. W. Washburn, who, with two sons and two daughters, survives him. For the next four years he was a professor in the Albany Boys' Academy, of Albany, N. Y. and for the succeeding year a professor, and during most of the year, acting principal, of St. John's College at Annapolis, Md.

In 1868, he was called to the newly established Illinois Industrial University — since become the University of Illinois — and took part in the organization of that institution, being closely associated with its first president, Dr. Gregory. After a single year's activity there, however, he accepted a very flattering offer from Rutgers College, and for the succeeding fourteen years filled the chair of political economy at that institution.

In 1873 he served as a member of the Board of Visitors to the United States Naval Academy. In 1875 he was a member of the commission to investigate the charges of corruption at

the Red Cloud Indian Agency preferred by Prof. O. C. Marsh, of Yale, having been added along with the Hon. Timothy Howe, of Michigan, by personal action of President Grant, to a commission of three, previously appointed by the Secretary of the Interior. In 1876, much against his wish, he was made the Republican candidate for Congress for his district. Although the district was hopelessly Democratic, he threw himself into the contest with characteristic energy and, while not elected, ran considerably ahead of the Presidential ticket. In 1878 he was appointed chairman of a commission to prepare and present to the legislature of New Jersey a digest and revision of the State system of taxation. While engaged in this work he found time to study law, and was admitted to the New Jersey bar while still carrying on his college work.

Both his studies in economics and his activity in public affairs naturally led him to interest himself in the development of industrial education, which occupied so large a share of educational thought during those years, particularly in connection with the land-grant act of 1862. In 1873 he presented an elaborate paper before the National Educational Association upon the subject "The Relation of the General Government to Education." In the course of this paper he traced in considerable detail the history and development of the land-grant colleges up to that time and emphasized those broad conceptions of their functions in our educational system and of the importance of the type of education which they were designed to give, to the concrete development of which he was to contribute so largely.

In 1882 he accepted the presidency of The Pennsylvania State College and began that work for which his previous life had been the unconscious preparation.

This institution was one of the first fruits of that revolution in the subject-matter and methods of education which characterized the middle years of the nineteenth century. Its foundation was so closely synchronous with that of the Michigan and Maryland agricultural colleges that the degree of priority is largely a question of definition. Chartered in 1855 and opened to students in 1859, its first five years gave promise of a successful

career; but later, through official neglect and public indifference, its affairs had reached a low ebb, and at the time when Dr. Atherton was elected president the entire work of the college was carried on in a single building, which also served to shelter the families of several professors, and the total assured income of the institution was $30,000 per year from the Morrill fund. For the following college year, 1882–3, the number of collegiate students dropped to 34 and the total enrollment to 87, while the graduating class numbered 5.

The growth of the college in numbers and in material equipment in the twenty-four years of Dr. Atherton's administration was nothing short of marvelous. The enrollment of 87 in 1882–3 became 800 in 1905–6; the graduating class, on whom he conferred their degrees at his last official act, numbering 86. The faculty increased in the same period from 16 to 66, besides 20 "assistants in administration." The work which in 1882 was carried on in a single building was, at the close of his administration, distributed among fourteen, the cost of the new buildings erected having been nearly $1,000,000, this including the magnificent Schwab Auditorium and Carnegie Library. The total of the State appropriations to the college during his presidency was nearly $1,500,000, as compared with $183,000 during all its previous history.

Despite the demands of his college work, Dr. Atherton found time and energy for other notable public activities. He was a leading spirit in the activities which resulted in the passage in 1887 of the Hatch act providing for the establishment of agricultural experiment stations, and also in 1890 of the second Morrill act providing further endowment for the colleges of agriculture and mechanic arts. He was largely instrumental in organizing the Association of American Agricultural Colleges and Experiment Stations and served two years as its first president. In 1887 he was appointed by Governor Beaver chairman of a commission of five, appointed under a joint resolution of the legislature, "to make inquiry and report to the next legislature . . . respecting the subject of industrial education." Special reference was had in the resolution to the question of the incorporation of industrial training into the existing system

of public education, and to the training of teachers for this purpose. The report of this commission, which was largely his work, was recognized as the most comprehensive and thorough treatment of the subject up to that time. In 1891 he was for the second time appointed on the Board of visitors to the United States Naval Academy and in 1895 he was appointed a member of the College and University Council of Pennsylvania, of which he continued a member until his death.

Dr. Atherton was an indefatigable worker, never sparing himself in the service of the college or of the larger public, and he inspired his associates with like zeal. He had the courage and poise of the born leader of men. Never dismayed or disconcerted by opposition or attack, accepting defeat as the stepping stone to future success, with an open mind welcoming every suggestion from others yet with supreme confidence in his own carefully considered conclusions, he bore his great responsibilities with a quietness and simplicity which were an inspiration to his associates. He was an optimist in the best sense, believing profoundly that right is stronger than wrong and that high and worthy ideals must ultimately triumph, and he showed his faith by his works.

HENRY PRENTISS ARMSBY.

Wilbur Olin Atwater.

1844–1907.

Prof. Wilbur Olin Atwater, whose death occurred September 22, 1907, at his home in Middletown, Conn., after an illness of nearly three years, was the son of a Methodist clergyman well known in New England, and was born in Johnsburg, N. Y., May 3, 1844.

He received his academic training at the University of Vermont and at Wesleyan University, Middletown, Conn., graduating from the latter institution in 1865. During a period of postgraduate study at Yale University, which led to the doctor's degree in 1869, he was associated with Professors S. W. Johnson and W. H. Brewer and had his attention called to agricultural chemistry and the great possibilities this subject offered to investigators. With an insight which characterized him throughout his career, he recognized the future possibilities of such work and from 1869 to 1871 he studied agricultural and physiological chemistry in the Universities of Berlin and Leipsic and acquainted himself with the European agricultural experiment station movement. His career as a college teacher began immediately after his return from Europe at the University of Tennessee and at the Maine State College, and he was thus brought into close touch with the movement for agricultural education and research which was at this time taking shape in the United States. He was called to Wesleyan University in 1873, where he held a professorship of chemistry for over thirty years and at his death was head of the chemical department in that institution.

The first agricultural experiment station in the United States was organized in Connecticut in 1875 largely through Professor Atwater's efforts, and he was made its first director. Interest in the experiment station movement spread rapidly and the passage by Congress in 1887 of the Hatch act made possible the establishment of such a station in every state and territory. In

Connecticut the unds were divided between two experiment stations and Professor Atwater was made director of the Storrs Station and retained this position for fourteen years. During this period a relatively large amount of scientific work along chemical lines and other lines related to agriculture was carried on by the station. Of especial interest were Professor Atwater's studies on the acquisition of atmospheric nitrogen by plants, begun several years prior to the establishment of the Storrs Station and continued as a part of the work of that station from 1888 to 1892.

On the invitation of Commissioner Colman, of the United States Department of Agriculture, Professor Atwater consented to become the first director of the Office of Experiment Stations, established in the Department of Agriculture for the general direction of the agricultural experiment station movement, accepting this position on the condition that he be permitted to retain the directorship of the Connecticut Storrs Station and his college professorship at Wesleyan University. That this Bureau has in later years followed with great success the general policies laid down by Professor Atwater is a proof of his wisdom and foresight in establishing this work.

A long list of articles in scientific and popular journals, in publications of the Connecticut Storrs Experiment Station and United States Department of Agriculture, etc., shows the contributions which Professor Atwater has made to the development of agricultural chemistry and agricultural education. Especially noteworthy is the establishment of the series of farmers' bulletins in 1889 under his advice and direction, a class of publications which has become of the greatest importance for the dissemination of information along agricultural lines. He was also founder of the Experiment Station Record, an abstract journal published in the Office of Experiment Stations, of which the first volume appeared in 1889. This journal covers the field of agriculture and related sciences and its circulation among students and investigators is world wide.

The influence of Professor Atwater on the development of agricultural research in the United States has been greatly broadened through the men who came into direct association

with him as students or co-workers and who have since become directors of agricultural experiment stations, professors in agricultural colleges, and influential in other capacities in the movement for agricultural education and research.

Parallel with his studies in agricultural chemistry, including animal nutrition, Professor Atwater began early in his career to carry on investigations in physiological chemistry with special reference to problems in human nutrition. Between 1879 and 1883 he made extensive studies of the chemical composition and nutritive value of American food fishes and invertebrates for the United States Commissioner of Fish and Fisheries and carried on work along similar lines for the Smithsonian Institution. Studies of the dietaries of people in Massachusetts and Canada were also made for the Massachusetts Bureau of Statistics of Labor and published in 1886. Nutrition investigations were also carried on during this period as part of the regular work of the Connecticut Storrs Experiment Station.

In 1893, Congress made an appropriation for investigations in human nutrition in coöperation with the agricultural experiment stations, assigning the supervision of this enterprise to the Department of Agriculture where it was made a part of the work of the Office of Experiment Stations. Headquarters for this enterprise were established at Middletown, Conn., and Professor Atwater was made its official chief. The work was broadly planned and steadily developed until it became the most comprehensive investigation on this subject ever undertaken. The coöperation of universities, colleges, and schools, experiment stations, public institutions, and private organizations of various kinds was secured in different parts of the country. Hundreds of dietary studies of people of different occupations were made and the results of similar studies throughout the world were collated. Numerous digestion experiments with men were carried on and special studies were made of the nutritive value of different cereals, meats, vegetables, fruits, and nuts, the effects of cooking and other forms of preparation on nutritive value, and other important food problems. Special efforts were made to improve methods and apparatus for such work.

In 1882–3, Professor Atwater devoted considerable time at

the Universities of Munich and Heidelberg in familiarizing himself with the German methods of studying nutrition problems, and familiarity with the Pettenkofer-Voit respiration apparatus, gained during this period, led him to undertake the construction of a similar device which should, however, include the measurement of the income and outgo of energy in addition to the income and outgo of matter. The respiration calorimeter, which was eventually developed by him and his associates is unrivaled in its class as an instrument of precision, useful for the study of a very large variety of problems connected with the physiology and nutrition of man and animals. The bomb calorimeter and the methods of its use were also materially improved under his direction.

The studies in human nutrition already made with the Atwater-Rosa-Benedict respiration calorimeter have been very important and promise to be still more so. Direct evidence has been obtained that the law of the conservation of energy holds good in the utilization of food in the human body; important data have also been obtained regarding the actual nutritive value of different foods and the relations of food to muscular energy and mental work.

As the Chief of Nutrition Investigations in the Office of Experiment Stations, Professor Atwater planned and supervised investigations which were carried on in about twenty States. The results of this work are embodied in about one hundred technical and popular publications issued by the United States Department of Agriculture and the Storrs Experiment Station.

In the judgment of competent experts, the nutrition investigations conducted under Professor Atwater's direction were more thorough in their scientific methods, more extended in the scope and amount of investigation, and more useful in the distribution and practical application of their results than any other inquiry of the kind ever undertaken in this country or in Europe.

Professor Atwater's aid was often sought in the study of nutrition problems. As instances may be mentioned the extended investigations of dietetic problems undertaken for the New York State Commission in Lunacy, studies of the nutritive value of alcohol carried on for the Committee of Fifty to

Investigate the Liquor Problem, and the series of investigations undertaken for the Carnegie Institution of Washington.

Professor Atwater's career as a teacher was markedly successful as is evidenced by the large number of his students and associates who are carrying on work in this and other countries of which he was in very large measure the inspiration.

As a public official working in a wide way in the organization and management of enterprises for the general good, Professor Atwater has earned the lasting gratitude of his countrymen, especially by what he did in connection with the agricultural experiment stations and the nutrition investigations. To this work he brought a well trained mind and a true scientific purpose. He had the enthusiasm and persistence necessary to impress other men with the importance of his enterprises and to carry him successfully over periods of opposition and discouragement. He had unusual ability in the conception and formulation of broad lines of work, and in attracting and holding men competent to give him such aid as he needed to complete these plans, put them into successful operation, and secure substantial results.

Professor Atwater was a member of many learned societies and received many honors in the United States and Europe. His influence on the development of agricultural education and research in this country and on the study of human nutrition has been of very great and prominent value.

A. C. True.

Swan Moses Burnett.

1847–1906.

SWAN MOSES BURNETT was born in New Market, Tennessee, March 16, 1847, and died in Washington, D.C., January 18, 1906.

He graduated in medicine from Bellevue Hospital Medical College, New York City, now the Medical Department of New York University, in 1870, and first settled in Knoxville, Tennessee, where he was engaged in practice for 5 years. In 1873 he married Miss Frances Hodgson. In 1875 he removed to the District of Columbia, and soon attained prominence as a specialist in ophthalmology and otology, as well as in literary and art circles. He is the author of a Treatise on Astigmatism, a Treatise on Refraction of the Human Eye, and over 64 distinct articles on diseases of the eye and ear, and chapters in text-books. He was associated with Dr. John S. Billings in the production of the National Medical Dictionary, and with Doctors Norris and Oliver in that of the "System of Ophthalmology." He also wrote a number of magazine articles and public addresses.

In 1878 he was appointed lecturer on ophthalmology and otology in the School of Medicine, Georgetown University, continuing in this capacity until 1883, when he became clinical professor, which position he filled until 1889, since which time until his death he was professor in those branches. In 1879 he established a post-graduate course in ophthalmology and otology, in connection with his hospital and private practice, and rendered most distinguished services as an author, teacher and clinician.

He was president of the attending staff of the Central Dispensary and Emergency Hospital, to which institution he gave much of his time and skill. He founded and equipped in said hospital the "Lionel laboratory" in memory of one of his sons, "Little Lord Fauntleroy." This laboratory was the first to be

established in connection with a hospital for clinical, bacteriological and pathological research in the City of Washington.

He was for many years the ophthalmologist and otologist of the Children's and Providence Hospitals, and also a member of the consulting staff of the Episcopal Eye, Ear and Throat Hospital. In 1889 he was elected president of the Medical Society of the District of Columbia, and was a member of the Washington Academy of Sciences, Philosophical Society, Anthropological Society, Historical Society, the American Ophthalmological and Otological Society. In 1896 he was elected to the presidency of the Cosmos Club of Washington, of which he was one of the founders.

His degree of Doctor of Philosophy was bestowed by the University of Georgetown in 1890. During his service extending over 25 years in the cause of higher medical education, he was distinguished for his devotion to his calling and was unexcelled as a teacher, scholar and gentleman. His kind, open and earnest manner, his clear, concise and comprehensive lectures could not fail to impress his students, while his shining example always upheld the ethics of the profession and the dignity of the physician and teacher.

Doctor Burnett died of chronic myocarditis, at his residence 916 Farragut Square, Washington. His second wife and his son Vivian survive him.

Among his literary contributions and important writings are the following: Translation of Edmond Landoldt's Manual of examination of the eyes. A course of lectures delivered at the École Pratique, Rev. Edit., VII, 9–312 pp., 1 ch., 1 table, 8°, Phila., 1879. A theoretical and practical treatise on astigmatism, VIII, 245 pp., 8°, St. Louis, 1882.

The principles of refraction in the human eye based on the laws of conjugate foci. 67 pp., 8°, Phila., 1904.

Study of refraction from a new viewpoint. Phila., 1905.

See also Billings, J. S. The National Medical Dictionary. Roy. 8°, Phila., 1890. — Landolt, E. The introduction of the metrical system into ophthalmology. 8°, London, 1876. Diseases of the conjunctiva and sclera. 82 pp., 2 pl., 8°, Phila., 1898, contained in Vol. II of Syst. Dis. Eye (Norris & Oliver).

Of the 64 distinct contributions to medical literature the following are mentioned:

A case of diplacusis binauralis with remarks. 10 pp., 8°, New York, 1877. Repr. from Arch. Ophth. & Otol., N. Y., 1876.

A case of choroiditis exsudativa. 11 pp., 8°, New York. Repr. from Arch. Ophth. & Otol., N. Y., 1877, 8°, VI.

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GEORGE M. KOBER.

James Carroll

1854–1907

JAMES CARROLL, the second in command on the Yellow Fever Commission, United States Army, was an Englishman, born at Woolwich, on June 5, 1854. His early years, like those of many men whose maturity is spent in a country not their own by birth, are little known, especially as his entire lack of egotism prevented his dwelling upon them. He was educated at a private school, Albion House, with a view to his entering the British Navy as an engineer student, but shortly before the time came for his admission, he emigrated to Canada. For some time after he reached Canada his life was that of a farmer in the backwoods, until, in course of time he came to the States, and in January, 1874, he enlisted in the United States Army.

Upon enlisting he was ordered to the far west, and while serving in Montana as a hospital steward he became interested in the study of medicine. After some difficulty he obtained permission to attend medical lectures at St. Paul, Minnesota, and from this time on he pursued his medical education as he could and where he could, until, on his return to the east he finally completed it at the University of the City of New York and the University of Maryland, receiving his degree of M.D. from the latter institution in 1891. He became intensely interested in the new science of bacteriology, then beginning to develop in this country, and availed himself of the graduate classes just opened at Johns Hopkins Hospital to prosecute this line of work. In 1895 he was assigned to duty in the Army Medical Museum at Washington, where Walter Reed was Curator, and from this time forward these two men were constantly associated as co-laborers. In 1899 Reed and Carroll were appointed by Surgeon-General Sternberg to investigate the true nature of the *Bacillus icteroides*, which Sanarelli had just declared to be the specific agent of yellow fever. Their work on this subject naturally associated their names prominently with

the great yellow fever question; and thus when, in 1900, an Army Medical Commission was appointed to go to Cuba and investigate the nature and transmission of this scourge of centuries, Reed was made Chairman with Carroll as second in command.

Carroll arrived in Cuba on June 25, 1900, and shortly afterward the preliminary experiments were begun. Early in the course of the work it became evident to the members of the Commission that the proposed line of work could not be carried on without experiments upon human beings and they agreed that the initial experiment must be made upon one of themselves. Carroll volunteered for this service, and he always said that the proudest circumstance of his life was that he was the first person to succumb to mosquito inoculation. He had a severe attack of the disease, during which his life was despaired of, and although he recovered, it was with an organic heart lesion which ultimately caused his death.

Carroll's services upon the Yellow Fever Commission, apart from the inestimable act of self-sacrifice just mentioned, were of the most essential character, and it is not at all too much to say that without his native force and perseverance, guided by his scientific knowledge and training, the work of the Commission could scarcely have been carried to a conclusion. Circumstances obliged Dr. Reed to leave Carroll in charge of the preliminary experiments while he himself returned to the United States on business connected with them, and it was entirely through Carroll's exertions at this time that they were brought to a satisfactory conclusion and the demonstration completed by the time Dr. Reed was again in Cuba. Again, in February, 1901, when the fact that yellow fever is transmitted by the *Stegomyia calopus* was definitely proved, and Reed went home, Carroll remained behind for several weeks to determine one or two additional points necessary to the perfect completion of their experiments. His most valuable, as well as his most independent service, of this description, however, was rendered in the following summer, when he returned to Cuba in order to undertake another line of experiments, intended to determine whether the specific agent of yellow fever is contained in the

blood. He encountered most serious difficulties before he could achieve his end, but it was finally accomplished, and without it the yellow fever experiments would undoubtedly have been far less useful to mankind. The points which were established by Carroll's individual efforts during this visit are:

1. That the specific agent of yellow fever is present in the blood during at least the first, second, and third days of the disease.

2. That the specific agent is destroyed, or at any rate attenuated by heating up to 55° C. for ten minutes.

3. That yellow fever can be produced by the injection of a small quantity of diluted serum taken directly from a patient and passed through a Berkefeld filter.

4. That, as the specific agent is capable of passing through a Berkefeld filter, it must belong to the class of organisms known as *ultra-microscopic*.

Yellow fever was not the only disease which Carroll employed his knowledge of bacteriology to investigate. In 1898 he was sent to Camp Alger to study the blood of the fever patients there and it was he who first showed that the illness prevailing among the troops there was typhoid fever and not malaria. On several other occasions he was employed to investigate typhoid fever.

After his return to the United States in 1901, Carroll continued to disseminate the valuable knowledge which he had acquired on the subject of yellow fever through the medium of the medical press. The first paper which he published independently, on "The Treatment of Yellow Fever," is the first contribution to the therapeutics of the disease after its mode of transmission became known; his last is the section on yellow fever in the second volume of Osler's "System of Medicine."

For some years Carroll's services received no official recognition, but during the last year of his life honors began to come to him in which he took a manly and justifiable pleasure. He was promoted from the rank of Lieutenant to that of Major, and two universities, the University of Nebraska and the University of Maryland, conferred upon him the honorary degree of LL.D. In the summer of 1907 the heart lesion, which originated in his

attack of experimental yellow fever, asserted itself and his health began to fail. He died at his Home at Washington on September 16, 1907.

In reviewing the facts of Carroll's life it is plain that he had the elements of success in him from the first. He was the typical *vir tenax propositi*, and this quality in his nature manifested itself in a persistence which, if not a necessary element of genius, is at least its closest ally and is often, pardonably, mistaken for it. His personal character was one which commanded respect and inspired the warmest affection. He was, as his former student, Dr. Donally, said of him, "a good man and a square," true and just in all his dealings, faithful in all his relations to those in authority over him, kindly and considerate to those under his command. Whatever his hand found to do he did it with his might, measuring the extent of his exertions by his duties and responsibilities, not by the value to himself of success achieved. He was modest almost to a fault and one of his most striking characteristics was a singular simplicity and trustfulness. He had an abiding sense of justice, his trust in human nature causing him always to believe that this sense was as strong in others as himself, while his belief in the final ordering of all things for good was the simple confidence of a child which trusts implicitly in higher powers whose failure to do right it cannot conceive.

HOWARD A. KELLEY.

Emil Alexander de Schweinitz.

1864–1904.

Emil Alexander de Schweinitz was born in Salem, North Carolina, in the year 1864. He was a son of Bishop de Schweinitz of the Moravian church, and a grandson of the Rev. Lewis David de Schweinitz, who is well known on account of his many additions to the knowledge of fungi and other plants in the United States. Emil Alexander de Schweinitz received his early education at the Nazareth Hall High School and the Moravian College of Bethlehem, Pennsylvania, and subsequently entered the University of North Carolina from which he received the degree of Doctor of Philosophy. From the University of North Carolina he went to the University of Berlin, and later entered the University of Göttingen, receiving from the last-named institution the degree of Doctor of Philosophy.

During the time spent in Germany the greater part of his labors was devoted to the study of chemistry and allied subjects. Upon returning to the United States he was engaged to teach chemistry in Tufts College, Massachusetts, and after a short while was made Professor of Chemistry in the Agricultural and Mechanical College of Kentucky. In 1888 he received an appointment as an assistant in the Division of Chemistry of the United States Department of Agriculture. On January 1, 1890, he was transferred from the Division of Chemistry to the Bureau of Animal Industry in the Department of Agriculture, and was placed in charge of the biochemical researches which were begun by the last named bureau on that date. The work along these lines increased so rapidly that a separate Division of Biochemistry in the Bureau of Animal Industry was created and Dr. de Schweinitz was placed at its head. This position he occupied until the day of his death.

After entering the Bureau of Animal Industry his labors were confined almost entirely to research work concerning the metabolic products of disease-producing bacteria, the chemical com-

position of the bodies of these bacteria and the production of immunity therefrom. Owing to the special interest of the Bureau of Animal Industry in those diseases which attack the domesticated animals, his attention was directed in great part to the study of the etiology, the treatment, and the methods of protection from such animal scourges as tuberculosis, hog cholera, swine plague and glanders. His most important contributions to science were probably those which dealt with the production of immunity from tuberculosis. While not the first to note a successful vaccination of laboratory animals against this disease, he was the first to record the use of attenuated human tubercle bacilli for the production of immunity from tuberculosis in cattle.

In the later years of his life he had given much time and energy to the production of a suitable vaccine for hog cholera. At the time of his death he had almost completed several extensive experiments dealing with the intertransmissibility of human and bovine tuberculosis. These experiments which have since been published, are generally recognized as important additions to our knowledge of this subject.

Dr. de Schweinitz was elected to membership in the American Public Health Association in 1896 and was also a member of the Section of Bacteriology and Chemistry from the time of its organization, having served on the council and various committees of the section. He was several times vice-president of international congresses on tuberculosis and hygiene which were held in Paris and Berlin, and his research work was well known and highly regarded abroad as well as in the United States.

In addition to the duties Dr. de Schweinitz performed as Chief of the Biochemic Division of the Bureau of Animal Industry, he was also Dean of the Medical School and Professor of Chemistry and Toxicology in that department of the Columbian University. In 1895 that institution conferred upon him an honorary degree of doctor of medicine. A complete bibliography of his writings has been prepared by Dr. Charles Wardell Stiles and may be found in *The Columbian University Bulletin*, No. 1.

His death, which was caused by uræmia, took place on

February 15, 1904, and came as the greatest shock to his co-laborers and friends. The Bureau of Animal Industry has lost a faithful and highly honored official and medical science has lost an investigator who did much toward clearing up the little-known paths of chemical pathology. We honored him for his scholarly achievements, and mourn his loss as that of a friend and an investigator who was cut off in the midst of his labors. As brilliant as was his past work, the future promised even greater achievements.

M. DORSET.

Daniel Coit Gilman.

1831–1908.

DANIEL COIT GILMAN was born in Norwich, Connecticut, July 6, 1831. In 1848, at the age of seventeen, he was admitted to Yale College and was graduated B.A. in 1852. His residence in New Haven was in the family of his uncle, Professor James L. Kingsley, whose varied learning, accurate scholarship and keen perceptions were stimulating and inspiring. In college he took a highly honorable position in scholarship, was president of the Linnæan Society, one of the editors of the *Yale Literary Magazine*, a member of Delta Kappa, of Alpha Delta Phi, and of the Beethoven Society, the Atalanta Boat Club, of Skull and Bones, and of Phi Beta Kappa. In the year following his graduation he was engaged in private teaching and literary work at New Haven, continuing at the same time his own studies, and was entered for some months as a resident graduate at Harvard College, where his home was with Professor Arnold Guyot.

In December, 1853, he and his life-long friend, Andrew Dickson White, sailed for Europe as attachés of the American Legation at St. Petersburg, under Ex-Governor Thomas H. Seymour, minister-plenipotentiary. Pending the arrival of Governor Seymour, whom he preceded by a few weeks, he traveled in England; and when he was not yet twenty-three years old, under the auspices of Mr. Richard Cobden and Mr. John Bright, at a large meeting of the National Public Association at Manchester, he delivered an address on "Common School Education in America," which was enthusiastically received. His connection with the legation at St. Petersburg afforded unusual facilities for observing the work of the great library and other institutions of learning, of technical schools, and reformitories, particularly for children of the Imperial Court, and of the great fortifications at Cronstadt during the French-English-Russian war. As a correspondent of the New York

Journal of Commerce, the *Independent*, and the *Tribune*, and as an occasional contributor to other periodicals, his letters, before the days of ocean telegraphs, not only from Russia but also from Berlin some months later, when he was a student in the university, were interesting and instructive. During his residence in Berlin he established lasting friendship with many distinguished scholars, among whom were Professor Perts, the historian and royal librarian, and, in the department of physical and political geography in which he was specially interested, with the eminent Karl Ritter and F. Adolph Trendelenburg. In 1855 he was appointed commissioner from the state of Connecticut to the Universal Exposition at Paris, where he became secretary of the Board of Associated Commissioners.

Returning to New Haven at the close of 1855 he was made assistant librarian of Yale College in 1856, and becoming librarian in 1858, he held that position until he resigned it in 1865. He was appointed secretary of the State Board of Education, was associated with the Honorable Henry Barnard in the publication of the *Connecticut Common School Journal*, and coöperating with Professor Arnold Guyot, prepared a series of school geographies and maps. He was also a contributor to Appleton's American Enyclopedia under the editorship of Charles A. Dana, and with Professor William D. Whitney and others, assisted Professor Noah Porter in the revision of Webster's Dictionary.

After resigning the office of librarian in 1865 he devoted himself more directly to his duties as professor of physical and political geography in the Sheffield Scientific School, to which office he had been appointed by the corporation of Yale College in 1863. Associated with Professor George J. Brush and others, he was efficient in extending and developing the work of the school of which he became practically the chief executive, securing for it large subscriptions for its permanent endowment, especially in connection with the munificent gifts of Joseph E. Sheffield, and Oliver S. Winchester and the family of Mrs. Cornelia L. Hillhouse, for an astronomical observatory. In 1870 he was elected President of the University of California, but declined the office, which, however, he assumed on his re-

election in 1872. Continuing in that position for three years he reorganized and greatly enlarged the work of the university and was successful in establishing it on the firm foundation where it has continued to grow and prosper.

Called to the presidency of the newly founded Johns Hopkins University at Baltimore in 1875, before a brick or stone had been laid, or a teacher or student enrolled, he devoted himself heart and soul to its organization and upbuilding, and at the end of a quarter of a century resigned the office, leaving behind him in the University and in the Johns Hopkins Hospital of which he was the first superintendent, and in the medical school of the University, enduring monuments of his genius as an organizer and administrator, of his inspiring influence with his colleagues and students as an educator, and of his wise discrimination in assembling a permanent staff of brilliant instructors and eminent scholars and scientists of Europe and America as occasional lecturers. From the beginning his motto was Men before Buildings.

He was a frequent contributor to newspapers and periodicals in regard to social science, civil service reform, charity organization, general education and scientific research. He delivered many academic discourses some of which were collated under the titles "University Problems" and "Launching of a University."

He was the biographer of James Monroe, in the Statesmen's Series, and of Professor James D. Dana of Yale College; was editor of the works of Doctor Francis Lieber and of Doctor Joseph P. Thompson, and of a new edition of De Tocqueville's Democracy in America. He was a contributor to Johnson's Universal Cyclopædia and was editor-in-chief of the New International Encyclopædia. He was chairman of the Committee on Awards at the Atlanta Exposition of 1895. He rendered efficient service as a member of the Venezuelan Commission in 1896, under appointment by President Cleveland. He was president of the American Bible Society; president of the American Oriental Society; one of the commission to draft a charter for the city of Baltimore, especially in the sections of Education and Charities; president of the Civil Service Reform

Association; president of the board of trustees of the John F. Slater Fund; vice-president of the Peabody Education Fund; an incorporator of the General Education Board, was for three years president of the Carnegie Institution, and became later a trustee of the Russell Sage Foundation. He received the honorary degree of Doctor of Laws from Harvard University and from St. John's College, Maryland, in 1876; from Columbia University in 1867; from Yale University and from the University of North Carolina in 1889; from Princeton in 1896; from the University of Toronto in 1903; from the University of Wisconsin in 1904; from William and Mary College and from Clark University in 1905.

In his multifarious and important duties he never sought political preferment, personal fame, or pecuniary reward, but through a life of great activity "held his rudder true" with an unswerving purpose to acquire and impart useful knowledge, and by his voice and pen and personal influence to realize the hopes of his youth in promoting and advancing sound education in all departments from primary and technical schools to the highest institutions of learning.

Between 1853 and 1908 he made ten voyages to Europe extending his travels to Algiers, Egypt and Jerusalem. The summer of 1908 was spent for the most part in southern Europe. He returned on October 7, seemingly in improved health, and after brief visits to his daughter and to relatives in Newport he went to the home of his sisters in Norwich, Connecticut, where he died suddenly on Tuesday afternoon, October 13, 1908.

He married in 1861, Mary Keycham, daughter of Tredwell Keycham, of New York. She died in 1869, leaving two daughters who survive their father.

In 1877 he married Elizabeth Dwight Woolsey, daughter of John M. Woolsey of Cleveland, Ohio, and niece of President Theodore Dwight Woolsey, of Yale University.

His domestic relations were of the happiest, and during his long official career the liberal and gracious hospitality of his household to all sorts and conditions of men, from youthful students to eminent scholars of world-wide distinction, contributed not a little to the promotion of the interests which were dear to his heart.

WILLIAM C. GILMAN.

William Rainey Harper.

1856–1906.

WILLIAM RAINEY HARPER died in Chicago, Illinois, January 10, 1906. He was born in New Concord, Muskingum County, Ohio, July 26, 1856, of Scotch Irish ancestors. He was born with fine mental faculties and a genius for constructive work. At the early age of eight years he entered the preparatory department of Muskingum College, a small denominational school in New Concord, and two years later he entered upon his collegiate course, completing it with honors and was graduated with the degree of Bachelor of Arts at the age of fourteen. He early developed a love for the Hebrew language and literature and delivered his commencement oration in that language on the day of his graduation. For three years after his graduation he pursued his studies without the aid of a master, holding closely and intently to his work, and at seventeen entered Yale University as a graduate student, receiving from that institution the degree of Doctor of Philosophy at the age of nineteen. Thus early did he discipline his fine intellect and bring his mental faculties under subjection to that tremendous will-power that was characteristic of him through all his brilliant career. He married the daughter of Rev. David Paul, President of Muskingum College, and spent a year as principal of the Masonic College at Macon, Tennessee. In the fall of 1876 he accepted an appointment as tutor in the preparatory department of Dennison University, and immediately his constructive and organizing power manifested itself in a plan for the development of Granville Academy. Before this work was commenced, however, he was called to the chair of Hebrew at the Baptist Union Theological Seminary in Chicago. While occupying this position he perfected a system of teaching Hebrew by correspondence, published text-books for the study of Hebrew, established two periodicals called the Hebrew Student and Hebraic, and started summer schools in Hebrew. He

became principal of the Chautauqua College of Liberal Arts and later of the entire Chautauqua system.

In 1886 he was appointed Professor of Semitic Languages in the graduate faculty of Yale University and in 1889 was appointed to the Woolsey Professorship of Biblical Literature in the same institution. September 18, 1890, he was elected President of the new University of Chicago. His letter of acceptance bears date February 16, 1891, and he entered upon his duties July 1 of that year. Beginning with a general outline of what the institution should become, he obtained funds to purchase about ten acres of ground for a site and secured one million dollars in money and pledges. With this beginning the Chicago University opened its doors in 1892. It is impossible in this brief statement even to sketch the marvelous growth of the university under his leadership. At the time of his death the university had over sixty acres of ground in a great city, forty buildings, fifteen millions of dollars in endowment and property, a faculty of three hundred and fifty professors and teachers, and over three thousand students. This result staggers belief and when one approaches the subject more closely and considers the infinite details of the work in securing the enormous contributions, in planning the buildings, in organizing the educational work, in securing the teaching staff, among whom were so many distinguished educators, and in turning to this institution such a large body of students, the mind and energy and consummate leadership of the man appear in their fullness and glory. It is not extravagant to say that history does not give a precedent or parallel of such an achievement.

But this was not all. In addition to this administrative and constructive work he was a great teacher and a productive writer.

The work he loved most was teaching. He was a master of his subject and he possessed the indefinable quality, common to all great teachers, that aroused the student to the greatest possible interest in his subject and compelled the student to zealous work. There was an influence which ran along the channel of his words that no words can interpret, which was an inspiration to everyone who listened to him. He did not seek so much

to make his students believe what he believed, but he taught them to think for themselves and reach rational conclusions. He brought them a feast of knowledge which they were to make their own by assimilation. He was both exacting and sympathetic with his students but he had no place for the man who would not make honest endeavor.

As a lecturer he won a brilliant place. Under his inspiring and enlightening treatment the plainest themes became alive with interest to almost any audience. As editor of the journals which he founded there was one purpose running through all of his work, and that was to popularize bible study and make higher education attractive. He wrote extensively for these journals during his life at Yale and Chicago. The list of books which he published upon his chosen and allied subjects and the important articles which he published in magazines are far too numerous to enumerate here. All this was done while he was planning for and bearing the heavy administrative duties of the great university. To those who knew him intimately he will always be remembered as the scholar and teacher, while to the world at large his creative genius in the establishment of the university will be his immortality.

The attractiveness and power of sincerity were well illustrated in his life. Although he did not possess the arts of oratory or brilliancy of style, thousands listened to him with intense interest and followed his leadership with enthusiasm.

Dr. Harper was a man of great faith. He believed in things not seen. He accepted faith as the evidence of things hoped for, and without doubting laid his plans and worked with tremendous energy to realize his hopes and justify his faith. He did not believe that anything worth having came by chance. He trained his mind, disciplined his will and believed in miracles wrought by human patience and toil. Only those who knew him intimately had any conception of his power of continuous application, of his endurance, and of the great multiplicity of labors which he performed. As a student and author he did a full man's part and his life would have been successful if he had done nothing more. As a teacher he bore his daily part and, judged by years of service and the quality of his work, he

measured up to the full requirements of ordinary life. In the organization, establishment and administration of the great university he accomplished in sixteen years what might well have been the labor of two generations of men. Not all that he planned and did will remain, but there is so much that will endure that there can be little room for regrets.

"By their fruits ye shall know them," is the divine test and measuring-rod that is ultimately applied to every man. Thus tested and measured, Dr. Harper stands pre-eminent. He died without worldly estate, but the historian will administer upon his possessions and find riches that neither time nor rust can corrupt nor the vicissitudes of human events diminish or take away. He belonged to the elite who are born into the world to do quickly some great work. These have little time for what the world calls pleasures. They begin with almost superhuman faith. They labor with masterful energy and take a direct line to the cross. But in the final accounting it is found that the world is vastly richer, that humanity has new aims and new impulses, and God and truth are more clearly apprehended because these men with dynamic souls have lived for a few years.

CHARLES WILLIS NEEDHAM.

Samuel Pierpont Langley.

1834–1906.

SAMUEL PIERPONT LANGLEY, the third Secretary of the Smithsonian Institution, astronomer and physicist, was born at Roxbury, Massachusetts, August 22, 1834, and died at Aiken, South Carolina, February 27, 1906.

He was educated in various private schools and the Boston Latin and High Schools, but owing to circumstances, he was prevented from adding to this the advantage of a college education. Nevertheless, he was a life-long student, was well grounded in literature and the fine arts, in modern languages and mathematics, and was altogether, aside from his scientific eminence, a broadly cultivated man. After leaving school, he devoted himself to architecture and engineering, and at the age of 23 went westward and spent the next seven years in Chicago and St. Louis, devoting his time to his profession, through which he gained a modest competence. In 1864 he abandoned what he had thought his life work and returned to New England, spending some time constructing a telescope, and later in European travel. Upon his return to Boston, the director of the Harvard College Observatory, Professor Joseph Winlock, invited him to become an assistant in that observatory, an offer which he accepted, and from that time he dated his scientific career.

In 1866, Mr. Langley became Assistant Professor of Mathematics in the United States Naval Academy at Annapolis where he reorganized the small observatory, the work of which had been interrupted by the Civil War. The following year he became associated with the Western University of Pennsylvania as Professor of Astronomy and Director of the Allegheny Observatory, where he remained for a period of twenty years. By his inventions and his original work on the solar spectrum, he gained that eminence which easily ranked him among the foremost scientific men of his day. His turn for business affairs

was shown when he secured a large portion of the money required for the equipment of the observatory by "selling time" to the railroads, a plan which resulted in great practical comfort to travellers by establishing a uniform time system, and finally by the standardization of time throughout the United States.

Mr. Langley's studies were largely directed to the sun, more especially to that part of the sun's energy known as the infra-red, for the investigation of which he invented a delicate instrument, the bolometer, now universally employed by astronomers. He aided and conducted numerous expeditions to observe the eclipses of the sun, the study of the corona and other phenomena, and in every case he secured successful results. Having great charm as a popular lecturer and possessing a singularly clear and beautiful literary style, he popularized the modern investigation of the sun and the science of astrophysics in his work "The New Astronomy," probably the most distinguished scientific memoir, from the literary point of view, ever produced by an American.

While still at Allegheny, Mr. Langley conducted a series of experiments which led to his further work in Washington in the solution of the problem of flying machines, or aerodromes, as he called them. After numerous experiments he succeeded, in 1896, in causing a steam driven machine, many times heavier than the air, to make a free flight of over three-fourths of a mile, and this was followed by another successful flight. These performances were afterwards repeated many times with aerodromes propelled by both steam and gas driven engines, so that to Mr. Langley will forever belong the credit of being the first to successfully maintain in the air a mechanical device many times heavier than the atmosphere, thus practically demonstrating the possibility of artificial flight. He later constructed a large aerodrome, capable of carrying a man, actuated by a 52 horse-power gasoline engine, which unfortunately on two occasions failed to be successfully launched.

After serving for a short time as Assistant Secretary of the Smithsonian Institution, in 1887 Mr. Langley succeeded Spencer F. Baird in his office as Secretary. During his administration the one large addition to the fund, since the foundation of the

Institution, was secured, and, largely through his personal efforts, two new branches, the Astrophysical Observatory and the National Zoölogical Park, were added to it.

The tributes in recognition of his work are almost too numerous to recite. He received the degree of D.C.L. from Oxford, D.Sc. from Cambridge, and, among numerous others, the degree of LL.D. from the universities of Harvard, Princeton, Michigan, and Wisconsin. He was awarded the Henry Draper medal by the National Academy of Sciences, the Rumford medal by the Royal Society of London, and the Rumford medal by the American Academy of Arts and Sciences, as well as the Janssen medal from the Institute of France, and the medal of the Astronomical Society of France. He was a foreign member of the Royal Society of London, a correspondent of the Institute of France, a fellow of the Royal Astronomical Society of London, member of the Royal Institution of London, member of the Academia dei Lincei, of Rome, of the National Academy of Sciences, and of many others.

He was also President of the American Association for the Advancement of Science, Vice-President of the American Philosophical Society, member of the Council of the National Academy of Sciences, and a Trustee of the Carnegie Institution. He was a man of a singularly retiring disposition and of a depth of affection which only those who knew him most intimately ever fathomed.

CYRUS ADLER.

Adolph Lindenkohl.

1833–1904.

ADOLPH LINDENKOHL was born at Niederkaufungen, Hesse Cassel, Germany, on March 6, 1833, and died in Washington, D. C., June 22, 1904. He graduated from the Polytechnische Schule, Cassel, in 1852. He came to the United States the same year, and in 1857 was admitted to American citizenship. He was employed in teaching for two years after coming to this country, and on July 1, 1854 was appointed to a position in the cartographic work of the Coast Survey, where he remained until his death, a remarkable record of fifty years of valuable service.

During the first year of this duty, James A. Whistler was a fellow employe for about three months. It was found to be a matter of difficulty to get the future distinguished artist to come to the office with that regularity expected by the government, or when there to devote himself to topographic drawing or to etching views for the charts, as he preferred to sketch heads and figures on the edge of the plates. Lindenkohl told of a personal effort to assist the young artist in punctuality, when he went one morning to his room, the walls of which were found to be covered with sketches on the plaster; the young artist was still in bed and so interested Lindenkohl in telling of his work that the only result was that neither got to the office that morning. In the last month of his service Whistler was credited with only six and one half days' work at one dollar and a half a day and the experiment of his employment was terminated without ill feeling on either side.

With others from the Coast Survey, Lindenkohl was assigned to duty with the army during a portion of the Civil War from 1862 to 1864. He assisted in a topographic survey on the Potomac River, and served as a topographer on the defenses of Baltimore. He also assisted in the compilation of data for various maps for the department of West Virginia.

In his regular duties in the office of the Coast Survey, Lin-

denkohl was engaged mainly in the compilation of data for charts and the preparation of charts for publication, and he was known particularly for the extensive store of information which he acquired as to the material available for the charts, as well as for the rapidity with which he worked; for instance in putting hachures or hill shading on charts he had both great speed and unusual skill.

He gave much attention both in connection with and outside of his official duties, to studies on subjects related to geography and the physics of the sea, particularly deep-sea temperatures, densities and currents. He wrote a number of articles on these and similar subjects, which were published in the Reports of the Coast and Geodetic Survey, *Petermann's Mitteilungen*, the *American Journal of Science*, and elsewhere.

In 1884, in a paper on the "Geology of the Sea-bottom in the Approaches to New York," he dealt largely with the submarine channel of the Hudson River. In a paper in 1895 on the Gulf Stream and circulation of the Gulf of Mexico he discussed the evaporation, precipitation and influx from rivers and currents, the variations of temperature and density in the Gulf waters, and the relation of these phenomena to the Gulf Stream. In 1897 he published the results of an investigation of the salinity and temperature of the North Pacific Ocean.

His inquiries along such lines are the more interesting because owing to the natural obstacles to investigations of the sea, in the present distribution of scientific effort the oceanographic problems are receiving less attention than their importance warrants.

At the time of his death Mr. Lindenkohl was the senior draftsman in the Coast and Geodetic Survey, having been rewarded by promotion through all the grades of his branch of the service. He was of a kindly and unassuming disposition, which endeared him to all with whom he came in contact.

G. R. PUTNAM.

Henri Louis Francois Marindin.

1843–1904.

Mr. Marindin was born at Lausanne, Switzerland, July 2, 1843, and received his early education in the Swiss schools. He came to the United States before attaining manhood, and finished his scholastic education in the Owego Academy at Owego, New York, 1860–1863.

He entered the Coast Survey as aid on November 26, 1863, and was soon assigned to duty in a party engaged in the survey of Roanoke River, North Carolina, made at the special request of Admiral S. P. Lee, flag officer of the North Atlantic blockading squadron, the party being quartered on the gunboat Seymour for that purpose. In 1864 he served in a topographic party at work in the vicinity of Bermuda Hundred, Virginia, under the orders of Major General Butler, with Brigadier General Weitzel in immediate charge of the work, and later in the same year, and in January, 1865, he served in a topographic party engaged in work along the Potomac River under the direction of Major C. S. Stewart. He thus began his service to the nation of his adoption by aiding in the perpetuation of the Union, and continued to serve his country faithfully until death ended his long and honorable career.

In 1865 he was engaged in special surveys for a canal route through Nicaragua, and in 1870 he was engaged in similar work on the Isthmus of Darien.

His special work in the Coast Survey was in the field of physical hydrography, and many important features in the currents and in the development of harbors and bars along the Atlantic and Gulf coasts of the United States have been made known to commerce as the result of his systematic and careful investigation of the complex problems presented as the result of the action of winds and tides on the waters of the sea. He spent more than eighteen years in command of vessels of the Survey while engaged in this work.

On March 24, 1897, he was appointed by President McKinley to represent the Coast and Geodetic Survey on the Mississippi River Commission, and after that date devoted much time and attention to the duties thus imposed upon him, but continued his regular work on the Survey whenever it was possible to do so. His particular ability was recognized by numerous special assignments to duty in connection with harbor boards to establish harbor lines, and in the establishment of speed trial courses for vessels of the navy, and is shown in several scientific discussions of various physical problems relating to hydrography which have appeared from time to time as appendices to the annual report of the superintendent.

His death took place March 24, 1904.

ISAAC WINSTON.

Herbert Gouverneur Ogden.

1846–1906.

HERBERT GOUVERNEUR OGDEN was born in New York April 4, 1846. He descended from Revolutionary stock, Francis Lewis, a signer of the Declaration of Independence, being one of his ancestors.

His career in the Coast Survey commenced in 1863, when the Civil War was at its height. In common with a number of his brother officers, he was assigned to duty with the army and then with the navy, participating in the dangers and vicissitudes of active warfare.

In 1865 he served as a topographer on the Nicaragua Expedition.

In 1870 he was a member of the first naval exploring expedition to the Isthmus of Darien.

In 1893 he had charge of a section of the exploratory surveys for locating the international boundary between Alaska and British Columbia.

He was appointed by the President one of the original members of the Board on Geographic Names, and continued a member until the time of his death.

These were special assignments. In the regular course of his duties in the Survey, as his experience increased with length of service, he showed his versatility by engaging in and eventually directing nearly every one of the many branches of the work.

In 1880 he was placed in charge of the Engraving Division of the office. This position did not, as its name would imply, consist solely of superintending the work of expert engravers. It involved a knowledge of the whole range of chart construction and publication from the surveying operations in the field to the final verification of the chart from the press. It required an encyclopædic memory for details both of methods and locali-

ties, since the accuracy of the finished product depended in a large degree on his decision.

In 1898 he was appointed Inspector of Hydrography and Topography. His new duties were rendered the more difficult from the fact that a change was being made in the organization of the Survey, and also on account of the rapid expansion of the field of work, due to the development of Alaska, the acquisition of Porto Rico and the Philippine Islands.

In this position it came within the scope of his duties to formulate a general plan for hydrographic and topographic surveys; to make field inspections of the work; also of the ships, and to supervise their repairs and maintenance. Only those engaged in the same lines of work can fully appreciate the importance and value of what Mr. Ogden accomplished. Of the many thousands who traverse our coasts in ships, there are few indeed who are aware to what extent they are indebted to him for the integrity and completeness of the charts on which their safety depends.

The leading trait of Mr. Ogden's character — the one which endeared him most to his associates, both old and young — was his unfailing interest in their welfare. His ever ready sympathy attracted the confidences of his juniors, and his advice and assistance was ever constantly sought by them. At the same time his loyalty to the service never allowed his kindly feelings to override his high sense of duty. Decided in his convictions, he was firm in refusing ill-considered or improper requests, but he could deny in such a tactful and considerate manner as rarely to wound the most sensitive.

Having a genial and sanguine disposition — a man of simple habits — his friends hoped and expected that there were many years of activity and usefulness before him.

It was ordained otherwise, and he died suddenly February 25, 1906.

D. B. WAINWRIGHT.

William Bramwell Powell.

1836–1904.

WILLIAM BRAMWELL POWELL was born at Castile, N. Y., on December 22, 1836. He was of English ancestry, being the fifth child of Joseph and Mary Dean Powell who emigrated from England to New York in 1830.

From his parents, who were persons of far more than ordinary force of character and intelligence, he inherited many of the qualities that distinguished him in life. Joseph Powell, his father, had a strong will, deep earnestness, and indomitable courage, while his mother, Mary Dean, with similar traits possessed also remarkable tact and practicality. Both were English born, the mother well educated, and they were always leaders in the social and educational life of every community where they dwelt. Especially were they prominent in religious circles, the father being a licensed exhorter in the Methodist Episcopal Church. Both were intensely American in their love and admiration of the civil institutions of the United States and both were strenuously opposed to slavery, which was flourishing in America when they arrived in 1830. For a time they remained in New York City and then removed to western New York, finally locating in the village of Castile, where, as before stated, William Bramwell was born. Because of the slavery question Joseph Powell left the Methodist Episcopal Church on the organization of the Wesleyan Methodist Church and became a regularly ordained preacher in the latter. It was in this atmosphere of social, educational, political and religious fervor that the future school superintendent grew up. When he was three years old the family moved to Jackson, Ohio, and then, in 1846, went on westward to South Grove, Walworth County, Wisconsin, where a farm was purchased. They were in prosperous circumstances, and the boy was active in the management of affairs, early exhibiting his trait for doing things well.

His early education was such as the country schools afforded but his parents ever held before him the importance of achieving the highest education possible.

In 1851 his family removed to Bonus Prairie, Boone County, Illinois, where a larger farm had been purchased. About 1853 the Wesleyan College was established at Wheaton, Illinois, and the family removed there in order to take advantage of the opportunities afforded. The father became one of the trustees and young Powell entered the preparatory classes. With intervals of teaching he continued in the college till 1855, when he entered the preparatory department of Illinois College at Jacksonville, Illinois. Here he continued a year, leaving to enter Oberlin College, Ohio. In 1858 he returned to Wheaton College and entered the Junior year. Leaving in 1859 to engage in his chosen profession of teaching, he was not graduated; but in 1865 Lombard University, Illinois, conferred on him the degree of A.M.

Mr. Powell's services as teacher and school superintendent extended over nearly half a century. He was principal of a school in Sharon, Wisconsin, for some time between 1854 and 1861; in 1861–2, principal of the Hennepin (Illinois) school; 1863 to 1870, Superintendent of the Peru (Illinois) schools; 1871–1885, Superintendent Aurora (Illinois) schools; 1885–1900, Superintendent of Washington Public (white) schools. In 1901 he visited the Hawaiian and Philippine Islands and Japan to investigate the schools and text-book needs of these countries.

Mr. Powell was a member of the National Geographic Society, Washington Academy of Sciences, National Academy of Political and Social Science, Anthropological Society of Washington and the National Educational Association. He was the author of a number of school books which have been extensively used in the public schools of the country. The chief of these are: "How to See, How to Talk and How to Write," published in 1880; and a "History of the United States for Beginners," published in 1900. He was also joint author of the "Normal Series of Readers" published in 1887, and a "Rational Grammar of the English Language," published in 1900.

The following estimate of Mr. Powell's character and work as a school superintendent is quoted from an article in a Chicago journal of education (*Intelligencer*, April 1, 1904.)

"During his forty years of service Mr. Powell labored unceasingly and untiringly to improve the public school system. In his chosen profession he felt the most profound devotion, the greatest pride and pleasure. He was an advanced thinker, a prophet, and as such was often in advance of his time in the scope and grandeur of his ideals. His interests were centered in the welfare of the children, believing that the proper educational training is that which best prepares for life, not merely from the standpoint of earning a livelihood, but that education which elevates above sordid, material views; that which makes the brain and heart capable of appreciating the good and beautiful, susceptible to the allurements of the larger life.

"He felt it to be the child's birthright to have the best in education that human effort can give. Influenced by these ideals, he was a pioneer in methods of object teaching, of training by seeing and doing. Believing that all education is based upon experience, and that only through the child's own experience can he be held to understand and appreciate the experiences of others as found in books, he strove to give the child such experiences as lead to the interpretation of the natural world and to an understanding of the social whole. To provide for these experiences he early introduced into his course the study of nature and the study of institutional life. He collected libraries that the children might broaden their text-book knowledge with a knowledge of and a sympathy with life."

The following passage from the same article does some justice to Mr. Powell's work in securing manual and industrial training in the public school system under his charge:

"A firm believer in the value of hand work, he was among the first to prepare a way for and to establish manual training and domestic science schools. Music, drawing and physical training also became part of the regular course in his schools; all of this before most schools had advanced beyond the three R's. In the Washington schools he strove as strenuously to provide the best facilities in manual training, in cooking and in

cutting and fitting as he did to provide the best of book instruction, thus giving to these new elements in education their proper standing. To him the genius of American civilization demands work — work of hand, heart and brain. He contended that getting knowledge by rational methods gives to the child mental and physical delight."

He was married in 1865 to Miss Minnie Paul, of Peru, Illinois, who with two children, Miss Maud Powell, the violinist, and Mr. William Paul Powell, of Mount Vernon, New York, survives him. His death occurred after a short illness at Mount Vernon, New York, on February 4, 1904.

PREPARED BY U. S. BUREAU OF EDUCATION.

Nicholas Senn.

1844–1908.

NICHOLAS SENN was born in Buchs, Canton of St. Gall, Switzerland, October 31, 1844, and died, at his home in Chicago, January 2, 1908.

He came to this country with his parents in 1852 and settled at Ashford, Wis. He was graduated from the Fond du Lac high school in 1864, after which he taught school himself and began the study of medicine with Dr. E. Munk, of Fond du Lac. He entered the Chicago Medical College in 1865 and graduated in 1868. In 1869 he married Miss Aurelia S. Muehlhauser, of La Crosse, and began the practice of medicine in Ashford. In 1874 he moved to Milwaukee and became an attending physician of the Milwaukee hospital. Returning to Europe in 1877, he studied at the University of Munich and received the medical degree in 1878. He then resumed practice in Milwaukee until 1893, when he moved to Chicago where he remained until his death.

During the comparatively brief period of thirty years — the period of his active professional life, from the time of his graduation in Munich until the date of his decease in 1908 — few men in any profession have performed more productive and excellent work, and certainly but few, if any, have received more honors in recognition of their distinguished service to humanity in the domain of medical science and practical surgery, than Dr. Senn.

In every sphere of professional activity, alike in his chosen field of operative surgery, as in the rôle of teacher and author; in his patriotic duties as a military surgeon; and in works of charity and benevolence, Dr. Senn "acted well his part."

His hospital work began as interne in the Cook County Hospital of Chicago. Then he became a member of the staff of the Milwaukee Hospital; and later Surgeon-in-Chief to the St.

Joseph's Hospital and Presbyterian Hospital, Chicago; and Surgeon to the Passavant and Polyclinic Hospital.

He was always deeply interested in military matters and military surgery. He was made Surgeon-General of Wisconsin in 1888 and retained the position until he left that State. In 1892 he was commissioned by Governor Altgeld Surgeon-General of Illinois and retained this position until his death.

At the outbreak of the Spanish-American War he assumed charge of the mobilization camp at Springfield and ably directed the physical examination of recruits. He was commissioned Lieutenant-Colonel and chief Surgeon, U. S. Volunteers, May 13, 1898, and was assigned to duty with the Sixth Army Corps. He went with the expedition under command of Brigadier-General Guy V. Henry, U. S. Volunteers, to Santiago, Cuba, and was assigned to duty as chief surgeon of the operating staff with troops in the field. He resigned September 6, and was honorably discharged September 17. In general orders from the Adjutant-General's office, dated February 13, 1900, Lieutenant-Colonel Senn was commended for his surgical work during the Cuban campaign and for making a scientific study of typhoid fever among the troops.

His work as a teacher of medicine began in 1884 when he was appointed Professor of the Principles and Practice of Surgery in the College of Physicians and Surgeons, Chicago. Four years later he became Professor of the Principles of Surgery and Surgical Pathology in the Rush Medical College, and later Professor of Military Surgery in the University of Chicago. He was also Professor of Surgery in the Chicago Polyclinic.

His lectures — always without notes — were eloquent, dramatic and attractive.

His contributions to American medical literature comprised something over three hundred titles, twelve of these being printed volumes, varying in size, but all of them replete with original matter. Many of them are used as text-books and standard works of reference in most American medical schools, and a good number have been translated into foreign languages. Chief among them may be mentioned his text-books on: "The Principles of Surgery," "Surgical Bacteriology," "Experi-

mental Surgery," "Pathology and Surgical Treatment of Tumors," "Intestinal Surgery," "Tuberculosis of Bones and Joints," and "Practical Surgery." He also wrote on the surgery of the pancreas, stomach and gall-bladder; as well as contributing several books of travel in which he gives his observation of diseases, physicians and hospitals in foreign countries.

In 1897 Dr. Senn was elected President of the American Medical Association. He was a member of the Philadelphia College of Physicians, the American Surgical Society, the American National Red Cross, the Norwegian Medical Society, the Swedish Medical Society, and others.

Also an honorary member of the D. Hayes Agnew Surgical Society, the Philadelphia Academy of Surgery, National Association of Railway Surgeons, Academy of Medicine of Mexico, Glasgow Academy of Medicine, Manila Medical Society, the Imperial-Royal Medical Society of Vienna, and the Royal Medical Society of Budapest. He also received the Order of Merit of the Japanese Society of the Red Cross by the sanction of the Emperor of Japan.

While it was not the privilege of the writer to enjoy any personal intimacy with Dr. Senn, those who were more fortunate in this respect speak of him as a truly great man; "master of his profession; always ready to sacrifice his personal interest and comfort for the service of his adopted country; intensely loyal in his friendships; generous to a fault; and too honest to harbor suspicions." "His greatest glory was in his extraordinary capacity for work, which he held as a duty, and that work entirely for the benefit of his fellow-men."

Among the substantial evidences of his generosity may be mentioned his endowment of two rooms in the St. Joseph's Hospital, Chicago; his donation to Rush Medical College of the Senn Clinical Building, and his presentation to the Crerar Library of a valuable collection of books, including the entire library of Dubois-Raymond and that of the late Dr. William Baum, Professor of Surgery in the University of Göttingen.

Taking him for all in all, it may truly be said: the world is better for his having lived.

A. F. A. King.

Samuel Edwin Solly.

1845–1906.

Dr. Solly was born in London, England, May 5, 1845, and died at Colorado Springs, Colorado, November 19, 1906. He received his early education in the best schools of his native land, and, following the footsteps of his distinguished father, he took up a medical career. Owing to a physical breakdown in his early career, his attention was naturally directed along climatological lines. Through his father, he was brought into intimate association with many of the distinguished practitioners of London. In this way, he became acquainted with the late Sir Morell Mackenzie, from whom he acquired his insight into laryngology and rhinology. In his thirtieth year he found it impracticable, from a physical point of view, to longer reside in London, so he turned his face toward the setting sun. We next find him in Manitou, Colorado, where he resided for some years, being the inspiration of the English colony at this place. While at Manitou he made an investigation of the mineral springs of that place. Shortly after the establishment of the city of Colorado Springs, he removed to that inviting and thriving town. His great life work was done at Colorado Springs. He never tired of singing its praises or writing of its glories. Several years ago he was very much interested in a movement started by the civic body of Colorado Springs in sending out the secretary of that organization on a tour of the principal cities of the country to proclaim the attractions of Colorado Springs as a sanitarium. Though much interested in all projects of a civic character that redounded to the benefit of his home city, he was much more interested in those projects which had for their purpose the recognition of the fact that it was the world's great sanitarium for those afflicted with tubercular affection. The Cragmoor Sanitarium was his ruling passion during the last few years of his life. This institution

was modeled on a most comprehensive system, as only the master hand of Solly could have formulated.

Dr. Solly was a man of remarkable attainments — a representative of the highest type of the intellectual Englishman; in medicine, he was a scholar with an investigative turn of mind; an executive of remarkable ability; a public-spirited citizen of the highest grade; and a writer upon climatological subjects whose fame and name are co-extensive with the realms of modern medicine. His personality was the most delightful that the writer of this article has ever known. He possessed a quiet and dignified bearing, a modest temperament, a genial disposition, kindness of thought and action, a courtesy of manner that never was at fault, a ready wit that never lent itself to sarcasm, a perfect host, a most welcome guest, strong intellectually, with high moral ideals, and the courage of his convictions — such was the character of the lovable man of whom we write and who won his way into the hearts of all who came within his presence.

CHARLES W. RICHARDSON.

Ainsworth Rand Spofford.

1825–1908.

AINSWORTH RAND SPOFFORD at the time of his death, which occurred at Holderness, New Hampshire, August 11, 1908, was Chief Assistant Librarian of Congress. He was born at Gilmanton, New Hampshire, September 12, 1825, and was the son of the Reverend L. A. and Grata (Rand) Spofford.

He was prepared for college by private tutors, but his health failing, he went west at this time, 1844, and located in Cincinnati. His fondness for books soon decided his career; for he soon entered upon the duties of a book seller and publisher and spent his leisure moments in the study of literature and modern languages. In 1850, he was one of the founders of the Literary Club, of Cincinnati, a vigorous and intellectual organization. In 1852 he married Sarah P. Partridge, who died in 1892.

His coming to Washington, D. C., was in 1861, when he was appointed by President Lincoln Assistant Librarian to Congress. For several years previous to this, he was Assistant Editor, 1859–1861, of the *Cincinnati Daily Commercial.* His great fitness for the position of librarian was soon recognized and in 1864 he was made Librarian-in-Chief, holding that position until 1897, when he was relieved of the executive burden and made Chief Assistant Librarian. He saw the Library of Congress grow from a collection of 70,000 volumes to that of 2,500,000 volumes. He was the first to suggest the need of a separate building for the Library and when Congress was slow to act, he kept the matter before it not only in his formal reports, but by a systematic disorder in the overcrowded old quarters — the library, that filled every space with books, boxes, maps, bundles, etc., leaving thus but little room for the visiting Congressmen.

As a librarian he was widely known for his comprehensive knowledge of books and their contents and was to public men

and students a veritable catalogue. It was a tradition among the guides that Mr. Spofford read every book that came to the library and that he knew the position of every book. A question or two addressed to him would save hours of laborious research. The writer, a year ago, had occasion to look up the subject of medicine versus superstition and going to Mr. Spofford asked if he would pick out several of the best books on the subject. Mr. Spofford, taking a pencil, wrote offhand from memory the title, the author, in some cases the chapter, of eleven books of reference on the desired subject. When General Lew Wallace was writing "Ben Hur," he appealed to Mr. Spofford to help him in proper material for the local color and literary atmosphere. Mr. Spofford proposed and exhibited book after book from the Congressional Library without satisfying General Wallace, and finally told the General that he would find what he wanted in the Harvard Library in such a room and such a shelf, situated "sixth from the south end."

He contributed to many newspapers, magazines and encyclopedias. He was editor of Catalogues of the Library of Congress, and of the Annual American Almanac from 1878 to 1889; edited with others, Library of Choice Literature (10 vols.), Library of Historic Characters and Famous Events (10 vols.), Library of Wit and Humor (5 vols.). He was the author of Practical Manual of Parliamentary Rules, 1884; and A Book for all Readers, etc.

Many of his writings dealt with the early history of our country and especially with the history of the Federal city. He was a firm believer in the "instinctive genius" of the French engineer, Major L'Enfant, who planned the city of Washington, and in endorsing a bill, February 11, 1905, presented to Congress, speaks of him as "the undisputed author of the grand scheme which was ultimately adopted."

He was a charter member and Vice-President of the Columbia Historical Society from its organization in 1894 to the date of his death. Among some of the papers he contributed were:

"The Methods and Aims of Historical Inquiry," May 7, 1894.

"Life and Labors of Peter Force, Mayor of Washington," June 8, 1897.

"Washington City in Literature," February 10, 1902.

"The Lyric Element in American History," December 14, 1903.

"The Eloquence of Congress: Historic Notes," November 13, 1905.

"Virginia, 300 Years Ago," April 8, 1907.

Mr. Spofford was a man of kindly and charitable disposition and of a temperament which once known, was as peaceful and attractive as the cooling rivulet on a summer day. Absolutely unconscious of his distinction and never courting notoriety, he came and mingled with us all, giving help, advice and encouragement to those who would drink of the Pierian spring.

JAMES DUDLEY MORGAN.

R. Stansbury Sutton.

1841–1906.

Dr. Sutton was born in Indiana, Pennsylvania, in 1841 and died suddenly at Pittsburg, Pa., April 21, 1906. He studied medicine in Philadelphia and graduated with honor from the University of Pennsylvania in the class of 1865. He soon settled in Pittsburg where he practised his profession with great success up to the day of his death. He had his wish, to die with his harness on, and not to linger long with a distressing illness, a burden to himself and an anxiety to his many friends.

He was happily married and was a devoted father and a most useful neighbor and friend. Though a successful general surgeon he was among the first of his confréres to adopt the specialty of gynecology and abdominal surgery. He was actually a pioneer in his work and fitted himself more particularly for its delicate and responsible duties by special studies and training in our large cities and by instruction in the clinics and hospitals abroad, to which he frequently returned for new ideas and a study of their especial technique.

In 1905, Dr. Sutton was appointed a delegate to the Madrid International Congress of Gynecology.

In order more successfully to conduct the special work to which he had dedicated his talents, he established, in 1883, one of the first private hospitals in the country, and devoted it to gynecology and abdominal surgery. He named it the Terrace Bank Hospital for Women, and conducted it for twenty years. During the recent Spanish war his ardent patriotism led him to offer his services to the government and he was appointed Chief Surgeon to the Second Brigade, Third Division of the First Army Corps.

Dr. Sutton was a frequent contributor to the medical journals and societies and was the author of a book on abdominal surgery, which was chiefly a history of his own special work. He was twice elected Vice-President of the American Gynecological

Society. He served as President of the American Academy of Medicine, and also of the Mississippi Valley Medical Association, and the Pittsburg Obstetrical and Gynecological Society. In 1884 he was elected Chairman of the Obstetrical and Gynecological Section of the American Medical Association. He was also a member of the British Medical and Gynecological Associations.

JOSEPH TABER JOHNSON.

Robert Bowne Warder.

1848–1905.

ROBERT BOWNE WARDER died at his home in Washington, July 23, 1905, after an illness extending over nearly a year.

Professor Warder was born in Cincinnati, O., March 28, 1848, and spent his early life in the country home at "Aston," North Bend, Ohio. His character was formed under the influence of the Society of Friends and this faith remained the dominant feature of his life. From childhood he showed the effect of his parents' training and example, in a broad and catholic view of the ethics of life, and in a love of truth and scientific investigation. This devotion to truth was an especial characteristic and governed his life and actions throughout.

He was graduated from a Friends' institution, Earlham College, at Richmond, Ind., in 1866, and afterwards spent some time at the Illinois State University, at Champaign, where he was instructor in chemistry and natural philosophy. This work of teaching seemed to show Professor Warder his natural bent, and his energy was thenceforth devoted to studying the broad principles underlying all natural science. He spent some years in traveling, chiefly in the western half of the United States, in connection with the different State geological surveys. In 1873 he went to Harvard, where he was graduated as B.S. in chemistry in 1874.

After graduating at Harvard he spent a year traveling in Germany, studying at Giessen under Heinrich Will, and at Berlin under Hofmann. His attention was, however, especially devoted to methods of teaching chemistry in the German universities, and the application of theoretical chemistry to the practical sciences. His chief aim was to fit himself in the broadest sense for his work of teaching. This was his main desire throughout life, to help others, and he never faltered. On returning to this country he was associated with Prof. F. W. Clarke at the University of Cincinnati from 1875 to 1879 as

professor of chemistry and physics. Professor Warder early saw the close relation between these then distinct branches of natural science, and his papers on "The Speed of Saponification of Ethyl Acetate" and "Evidence of Atomic Motion within Liquid Molecules" were pioneer investigations in the field of physical chemistry of to-day.

He was engaged in this line of research from 1879 to 1883 when he accepted the chair of chemistry at Purdue University, where he remained until 1887. This position carried with it the duties of State Chemist, work of a commercial character rather foreign to his natural tastes, but to which he gave the same painstaking devotion that characterized all his work. Even these routine analyses were made to pay tribute to physical chemistry, as is shown by papers on "Influence of Time in Fertilizer Analysis," "Speed of Dissociation of Brass," etc.

In 1884 he married Gulielma M. Dorland, who also belonged to the Society of Friends, and like himself was interested in evangelical work. Their life together was one of perfect harmony.

It was probably about this time that Professor Warder felt more keenly than ever the call to help others in another field than chemistry. His philanthropic and evangelical work had always been foremost in his mind and labors, and in 1887 he accepted the professorship of chemistry at Howard University in Washington. Here he labored until he died, teaching chemistry and physics, but above all setting an example and teaching the principles of a Christian life with an unselfish devotion.

In spite of lack of facilities, his work at this period on "Dynamical Theory of Albumenoid Ammonia," "RecentTheories of Geometric Isomerism," "Cross Fertilization of the Sciences," and "The Major Premise in Physical Chemistry" showed his natural inclination to this phase of chemistry.

Professor Warder's later papers were chiefly devoted to applying the laws of mass action to and showing the speed of chemical reactions for the analytical data obtained by other investigators.

He was essentially a critic and his devotion to truth caused him to scrutinize the investigations of others with the same

zealous care with which he looked for flaws in his own work. This high standard, coupled with an unusual modesty, often caused a hesitation which sometimes obscured his really profound knowledge.

No one went to Professor Warder for aid and was turned away empty-handed. What he had was given freely, and he seemed to feel that no labor was too great in his fundamental desire to help others.

S. S. VOORHEES.

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Note.— New names in **black-face type**, synonyms in *Italics*.